TRANSCRIPT OF RECORD.

SUPREME COURT OF THE UNITED STATES.

No. 1165.

OVERLAND TELEPHONE CO. ET AL., APPELLANTS,

v.

AMERICAN BELL TELEPHONE COMPANY ET AL.

APPEAL FROM THE CIRCUIT COURT OF THE UNITED STATES FOR THE SOUTHERN DISTRICT OF NEW YORK.

FILED OCTOBER 15, 1886.

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Copy of testimony for Gray in Speaking Telephone Interference.

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THE PRESIDENT OF THE UNITED STATES OF AMERICA

TO THE OVERLAND TELEPHONE COMPANY, ROBERT G. DUN, SYLVANUS C. BOYNTON, I. NEWTON EWELL, JOHN W. BARROW, ERASTUS WIMAN, PETER P. POPE, JACOB MOESER, CHARLES P. CROSBY AND SETH R. BECKWITH, *Greeting:*

You are hereby commanded, that you and each of you personally appear before the Judges of the Circuit Court of the United States of America, for the Southern District of New York, in the Second Circuit Court, in Equity, on the first Monday of May, A. D. 1883, wherever the said Court shall then be, to answer a bill of complaint exhibited against you in the said Court by the American Bell Telephone Company and Metropolitan Telephone and Telegraph Company, and do further and receive what the said Court shall have considered in that behalf. And this you are not to omit under the penalty on you and each of you of two hundred and fifty Dollars.

Witness: Honorable Morrison R. Waite, Chief Justice of the Supreme Court of the United States at the City of New York, on the twelfth day of April, in the year one thousand eight hundred and eighty-three, and of the Independence of the United States of America the one hundred and seventh.

TIMOTHY GRIFFITH,
Clerk.

DICKERSON & DICKERSON,
Complainants' Sol'rs.

The Defendants are required to enter appearance in the above cause in the clerk's office of this Court on or before the first Monday of May, 1883, or the bill will be taken *pro confesso* against them.

T. G.,
Clerk.

(Subpœna endorsed.)

I certify that the within writ was personally served on the within-named defendants, at the time and in the manner set forth in the annexed affidavit of William T. Smith.

Dated N. Y., April 14, 1883.

(sgd.) JOEL B. ERHARDT,
U. S. Marshal.

(Affidavit of service of Subpœna.)

SOUTHERN DISTRICT OF NEW YORK,
CITY AND COUNTY OF NEW YORK, ss.

William T. Smith, being duly sworn, deposes and says, that on the 13th day of April, 1883, he served the within-named defendants, Robert G. Dun, personally, individually and as President of the Overland Telephone Company, and Erastus Wiman, at their place of business, No. 314 Broadway, in the City of New York, and on the same day, at No. 160 Broadway, he served upon the within-named defendants, Peter P. Pope, Joseph Moeser, Charles P. Crosby, Seth R. Beckwith, I. Newton Ewell, Sylvanus C. Boynton, personally, a copy of the within subpœna, at the same time showing to each of them the annexed original.

(sgd.) WILLIAM T. SMITH.

Sworn to before me this 14th day of April, 1883.

[SEAL] (sgd.) E. C. MARSHALL.
Notary Public N. Y. Co.

Circuit Court of the United States,

SOUTHERN DISTRICT OF NEW YORK.

IN EQUITY.

AMERICAN BELL TELEPHONE COMPANY ET AL.

v.

THE OVERLAND TELEPHONE COMPANY ET AL.

BILL OF COMPLAINT.

To the Honorable the Justices of the Circuit Court of the United States for the Southern District of New York:

The American Bell Telephone Company, a corporation duly established under the laws of the Commonwealth of Massachusetts, and the Metropolitan Telephone and Telegraph Company, a corporation duly established under the laws of the State of New York, bring this their bill of complaint against the Overland Telephone Company, Robert G. Dun, Sylvanus C. Boynton, J. Newton Ewell, John W. Barrow, Erastus Wiman, Peter P. Pope, Jacob Moeser, Charles P. Crosby and Seth R. Beckwith, all carrying on business in the City of New York, in the State of New York, judicial district aforesaid. And thereupon your orators complain and say that before the seventh day of March, 1876, Alexander Graham Bell, then of Salem, in said Commonwealth, being the original and first inventor of a new and useful improvement in telegraphy, which was never known or used before his invention thereof, and which had not at the time of his application been in public use or on sale for more than two years, made application according to law for Letters Patent of the United States to be granted to him therefor, upon which application, due proceedings being had in all respects, said Letters Patent were on the seventh day of March, 1876, granted, issued and delivered to said

Alexander Graham Bell, signed by the Secretary of the Interior and countersigned by the Commissioner of Patents, and numbered 174,465, whereby there was secured to said Alexander Graham Bell, his heirs, administrators or assigns, for the term of seventeen years from the said seventh day of March, 1876, the full and exclusive right and liberty of making, constructing, using and vending to others to be used, the said improvement, a description whereof is given in the words of the said Bell, in the schedule annexed to said patent, and forming a part thereof, as by said patent, numbered 174,465, or a copy thereof, here in court to be produced, will fully appear.

2. Before the thirtieth day of January, 1877, the said Alexander Graham Bell, being the original and first inventor of another new and useful improvement in electric telegraphy, which was never known or used before his invention thereof, and which had not at the time of his application been in public use or on sale for more than two years, made application according to law for Letters Patent of the United States to be granted to him therefor; upon which application, due proceedings being had in all respects, said Letters Patent were, on said thirtieth day of January, 1877, granted, issued and delivered unto said Bell, signed by the Secretary of the Interior and countersigned by the Commissioner of Patents, and numbered 186,787, whereby there was secured to said Bell, his heirs, administrators or assigns, for the term of seventeen years from the said thirtieth day of January, 1877, the full and exclusive right and liberty of making, constructing, using and vending to others to be used, the said improvement, the description whereof is given in the words of said Bell in the schedule annexed to said last-named patent, and forming a part thereof, as by said patent, numbered 186,787, or a copy thereof, here in court to be produced, will fully appear.

3. Said Alexander Graham Bell assigned said Letters Patent, numbered respectively 174,465 and 186,787, to Gardiner G. Hubbard, trustee, by deed of assignment dated July 9, 1877, and recorded at the Patent Office, July 28, 1877, Liber R[21], page 399 of Transfers of Patents. That said Gardiner G. Hubbard, trustee, assigned said Letters Patent, numbered respectively 174,465 and 186,787, to the Bell Telephone Company, by assignment dated July

20, 1878, and recorded at the Patent Office, Oct. 3, 1878, Liber Y[22], page 460 of Transfers of Patents.

4. Said Bell Telephone Company has granted the same to your orator, the American Bell Telephone Company, by an instrument in writing, dated June 22, 1880, and recorded at the Patent Office, June 24, 1880, Liber I [illegible], page 282 of Transfers of Patents.

5. The sole right to manufacture electro-speaking telephones under said patents thereby became and still is vested in the said American Bell Telephone Company; that the only right granted to or possessed by any persons other than the said American Bell Telephone Company under said patents has been and is the right to use telephones procured from said American Bell Telephone Company, and its predecessors, upon payment of stated royalties under said two patents to the said American Bell Telephone Company.

That by license under said American Bell Telephone Company, the Metropolitan Telephone and Telegraph Company, a corporation organized under the laws of the State of New York, has acquired the sole and exclusive right to use and to license others to use telephones within a territory which includes all the States of New York and New Jersey within thirty-three miles of New York City Hall, and all of Monmouth County, New Jersey, and all of Long Island, and is now engaged in the business of supplying electric speaking telephones and erecting telephone lines in said territory; which telephones it receives from said American Bell Telephone Company, and for the use of which it pays a yearly license fee and royalty to said American Bell Telephone Company, and receives a yearly royalty and license fee from its sub-licensees.

6. Electric speaking telephones had never been publicly known or used before the grant of said patent, and were first publicly made known and first introduced into public use by said Bell and his licensees under said Bell patent, and but for the unlawful acts of the defendant hereinafter complained of, your orators would be in the full and exclusive enjoyment of said rights.

7. Your orators further show, that after the grant of said Letters Patent, the inventions therein described and claimed, or substantial and material parts of the same, embodied in instruments known as Bell telephones, and in instruments known as Blake transmitters,

were, before July, 1877, introduced into general public use by the said Bell, the said Hubbard, trustee, the said Bell Telephone Company and your orators. That many thousands of persons have put the said inventions into daily use under the authority and license of the said Hubbard, and your orators and their predecessors and those holding rights or licenses under them, and have paid for such use of said inventions the amount fixed by the owners of said patents as a reasonable compensation therefor, such payments amounting in the aggregate to many thousands of dollars. That telephone exchanges now exist in more than five hundred towns and cities of the United States, and in every State thereof, and exist in substantially every city in the United States having more than 10,000 inhabitants, and in many smaller places; and all said exchanges use telephones licensed by your orators, the American Bell Telephone Company, and its predecessors, as owners of said Bell patents, and pay royalty therefor to your said orator. That the fact that said Bell was the original and first inventor of said inventions, and that the patents above named are good and valid patents, has been generally recognized and acknowledged by those who have used the inventions and the public generally, in all parts of the United States, and the claims of the said Bell, Hubbard, and your orator and its said predecessors to the exclusive right to the said inventions under said patents have been generally acknowledged and acquiesced in. That from time to time several persons have attempted to make, sell and use telephones, or parts thereof embracing said inventions, but that in such cases said Hubbard while owner of, and your orator, and its said predecessors, since they have owned said patents, have immediately, upon hearing of such acts or attempts, notified such parties to desist therefrom, and that such parties have generally, upon receiving such notices, complied therewith, and acquiesced in and recognized as valid the claims of said Hubbard and your orator under said patents; and said Bell, said Hubbard and your orator have always asserted and maintained, and but for the wrongful acts of the defendants would, and have hitherto, almost universally enjoyed the sole and exclusive right to practise said inventions; that they have not acquiesced in any infringement of their exclusive rights; that no persons or parties except your orator, the American Bell Telephone Company, and its

licensees are now openly engaged in the manufacture or use of electric speaking telephones, save and excepting the defendants and possibly a few small infringers whom your orator is about to proceed against; and that the said exclusive rights of your orator are of great value to it.

8. There are now in use more than 200,000 electric speaking telephones licensed by and paying royalty to your orator, the American Bell Telephone Company; that the owners of said Bell patents, and those who now are or heretofore have been licensed by them, have devoted great time and attention and large sums of money to the development of the telephone and the introduction thereof into extensive use, and to the proper construction of the most suitable telephone lines and systems and telephonic appliances, and have constructed many thousand miles of telephone lines for public use with telephones owned by your orator, the American Bell Telephone Company, and licensed by it for such use, and that nothing which the defendants, or either of them have done, has contributed in any substantial way to the development of the telephone, or the introduction thereof into use.

9. From time to time sundry persons have undertaken to manufacture and use electric speaking telephones, and to infringe the said patents; that the owners of said patents have required them to stop, and for the most part they have, upon being so notified, desisted from such infringement; that your orator, the American Bell Telephone Company, and its predecessors, owners of said Bell patents, have brought suit in the courts of the United States and obtained injunctions and decrees against such infringers; and among the suits so brought and which have resulted in injunctions or decrees are the following: —

10. The said exclusive rights of said Bell, and your orator, the American Bell Telephone Company, and its predecessors, as his assigns and grantees, have never been openly or publicly violated, to any considerable extent, except at one time and in the year 1878, by the Western Union Telegraph Company, and by the Gold and Stock Telegraph Company, and by the American Speaking Telephone Company, said three corporations having associated them-

selves together for that purpose; that said Bell Telephone Company brought its bill in equity in the Circuit Court of the United States for the District of Massachusetts, against Peter A. Dowd, an agent of said associated companies, engaged in the business of using their infringing telephones, and in said suit complained of the defendant that he had infringed the fifth claim of said patent 174,465; and also complained that he had infringed the third, sixth, seventh and eighth claims of said patent 186,787; the said associated corporations assumed the defence of said suit, and employed in said defence their counsel and experts learned in the law and skilled in the art; in said suit evidence was taken and completed by the complainants in chief, and by the defendant in defence, and by the complainants in reply; and thereupon, upon consideration of said proof and the opinions of their professional advisers, the defendant and said corporations became satisfied that said Bell was the true, original and first inventor of the electric speaking telephone, and the invention covered by said patents; whereupon they submitted to the said claims of the complainants, and agreed to desist from further infringements, and have since desisted from further infringements, and placed and caused to be placed all telephones within their power or control under license under said Bell patents, and paid, or caused to be paid, the usual and customary yearly royalties therefor habitually charged by the assigns of said Bell to other parties for like uses, and agreed that they would not thereafter make electric speaking telephones, and would not thereafter use electric speaking telephones, except such as should be made and furnished to them by your orator or the assigns of said Bell, and under license under said Bell patents, and that for the use of the same they should pay not less than the usual and accustomed royalties from time to time charged to others by your orator, and in accordance with the said advice of counsel of said telegraph companies a final decree was thereafter made and entered in said suit for the complainant, with the consent of the defendant Dowd, and in and by said decree the said two Bell patents were adjudged and declared to be valid patents, and the defendant was perpetually enjoined from infringing the same.

11. In the year 1880 the People's Telephone Company, a corpo-

ration organized under the laws of the State of New York, and Frank A. Klemm, Joseph Loth, Julius Bien, Marcus Marx, Auguste H. Girard, John N. Goodwin, Ernest Marx, Edgar W. Chellis, Richard C. McCormick, Henry D. Cook, Jr., Max L. Gutmann, Moritz Loth and Simon Wolf did make, sell and use, and threaten to make, sell and use certain electric speaking telephones, some of which were known as the "Klemm" telephones, and some of which were known as the "Tisdel" telephones; that said defendants owned the alleged inventions of Frank A. Klemm and of Abner G. Tisdel, and of Daniel Drawbaugh, relating to electric speaking telephones; that thereupon your orator, the American Bell Telephone Company, and the Metropolitan Telephone and Telegraph Company, a licensee of said American Bell Telephone Company, did, in the Circuit Court of the United States for the Southern District of New York, file a bill in equity against all of said parties, complaining that such acts done and threatened infringed the rights secured to the said orators by the said two Bell patents, 174,465 and 186,787; and did also move for an injunction thereon *pendente lite;* said motion came on to be heard in said court, before the Hon. Samuel Blatchford, Circuit Judge, on the nineteenth day of November, 1880, on affidavits and proofs filed by the respective parties, and was argued by counsel, to wit, Chauncey Smith and James J. Storrow, Esquires, for the complainants, and by George Harding, Esq., for the defendants; upon consideration whereof the Court did order an injunction as prayed for, restraining the defendants from infringing the said two patents of your orator, numbered 174,465 and 186,787; that such injunction issued accordingly on the twenty-second day of November, 1880; and your orator refers to a copy of the record in suit, to be produced, and prays that the same may be made part thereof.

12. In the year 1880 the Eaton Telephone Company, and its associates, did infringe said patents in New York by making and selling an electric speaking telephone apparatus, composed of a magneto-telephonic receiver of a form and style called by them the Eaton Magneto Telephone, and of a microphone battery telephonic transmitter, with carbon contacts; and did infringe said Bell patents in Massachusetts by selling the same to others by their employee, Albert L. Spencer; whereupon your orator, the American Bell

Telephone Company, brought suit against said Eaton Telephone Company and others in the United States Circuit Court in the city of New York, and against said Spencer in Boston, complaining that said defendants had thereby infringed claim 5 of patent 174,465, and claims 5, 6, 8, of patent 186,787; and said Eaton Telephone Company and their associates defended said two suits, and employed in that behalf counsel learned in the law and experts, whereupon a preliminary injunction was issued in both suits. Afterwards said suits were prepared for final hearing, and the defendants denied the validity of said patents, and denied that the use of a microphone telephonic transmitter, with carbon contacts, infringed said patents; and in support of such denial, and of other allegations in their answer, they introduced evidence; and among other evidence they introduced the depositions of Elisha Gray and of William M. Goodridge, and of Henry Morton and of Edward S. Renwick; and the same evidence on both sides was introduced in said two suits. Said suit in Boston came on to be heard on final hearing before his Honor Judge Lowell, Circuit Judge at Boston, and was argued by counsel; and was, on June 27, 1881, decided by the Court in favor of the complainants; and in its said decision the Court, among other things, expressly held and decided that all the said claims of said patents sued on were good and valid claims, and that said patents were valid patents, and that the use of the kind of speaking telephone transmitter, commonly known as a microphone transmitter with carbon contacts, whereby the resistance of a battery circuit was varied by variations of pressure, due to vibrations imparted to one electrode by sound waves, infringed said fifth claim of the Bell patent 174,465. Your orator craves leave to refer to the record of said case and to the opinion of said Court therein pronounced, and that the same may be made and deemed to be part hereof.

Also the following: —

13. A suit in the United States Circuit Court in Boston, brought in 1878 against Addison D. Hard, electrician, which resulted in a preliminary injunction; afterwards the said defendant made and exposed for sale some parts of electric speaking telephones, to the end that the purchasers thereof should complete and use the same; whereupon, after hearing, he was adjudged guilty of contempt and

ordered to pay a sum of money into court, which sum was afterwards ordered to be paid and was paid to the complainant, the Bell Telephone Company. Said suit has been terminated by a final decree for the complainants.

14. A suit in the same court against Jerome C. Redding, electrician, in 1878, which resulted in a preliminary injunction and a final decree for the complainants.

15. A suit in 1878, in the United States Circuit Court in New York, against Jesse H. Bunnell, manufacturing electrician, who appeared by counsel, and the suit resulted in an injunction and a final decree for the complainants.

16. A suit in 1878 against Charles E. & W. H. Jones, in the United States Circuit Court in Cincinnati, wherein said defendants appeared by counsel, and in which a final decree declaring the validity of said patents and enjoining further infringement thereof was issued against them.

17. A suit in 1880 in the United States Circuit Court in New York, against Pearce & Jones, manufacturing electricians, in which said defendants appeared by counsel, but which resulted in a final decree declaring the validity of said patents and enjoining further infringement thereof.

18. A suit in 1880 in the same court, against J. L. Lazzelle, a manufacturer of electrical apparatus, complaining that he infringed said patents by making and selling a form of magneto telephones, sometimes called "Lazelle" telephones, and a form of microphone telephonic transmitters, sometimes called the "Little Gem" transmitters; and this suit resulted in a preliminary injunction, and a final decree and perpetual injunction.

19. A suit in 1881 in the United States Circuit Court in Chicago, against Edward E. Harbert and Harbert & Co., manufacturing electricians, in which said Harbert appeared in person and a hearing was had, which resulted in a preliminary injunction, and a final decree and perpetual injunction.

20. A suit in 1881 in the same court against "The Foster Magnet Telephone Company," Gay W. Foster and others, in which the defendants appeared by counsel, and which resulted in a prelim-

inary injunction and a final decree establishing the validity of said patents and perpetually enjoining all further infringement thereof.

21. A suit in 1881, in the United States Circuit Court in New York, against Henry Thau, manufacturer of electrical apparatus, who appeared therein by attorney, and which resulted in a final decree and perpetual injunction.

22. In 1881, a suit was brought on said two Bell patents in the Circuit Court for the Southern District of New York against one Albert Craney and others, who used at West Point, on premises belonging to the Military Academy of the United States, a certain telephone apparatus known as the "Eccard Telephone," which is substantially described in United States patent No. 214,029, granted to Adolph Eccard, April 8, 1879. The said defendants by the procurement and at the expense of said Eccard and his associates, who were also made defendants, appeared by their counsel, John H. Latrobe and Causten Browne, Esqs., and filed an answer; thereupon evidence was taken for complainants.

The defendants failed to take evidence and gave up the contest; and upon the day of hearing the Court ordered a final decree against them, and thereupon a final decree and perpetual injunction issued against them.

23. In the year 1881, Amos E. Dolbear and others infringed the said Bell patent No. 174,465 by the construction and use of a certain telephone apparatus, which consisted of a microphone transmitter and a condenser receiver.

A bill of equity was thereupon filed against said infringers in the Circuit Court of the United States for the District of Massachusetts.

A motion for preliminary injunction was made therein, which was heard before Mr. Justice Gray and Judge Lowell, and the injunction was by them ordered after a full and elaborate hearing, which was accompanied by an opinion, a copy of which the claimants will produce, and to which they crave leave to refer.

24. In the year 1882 the People's Telephone and Telegraph Company infringed the said two Bell patents by making speaking telephones, and by causing them to be sold and used in the District of New Jersey, by John J. Ghegan. Suit was brought against the said Ghegan, and motion for preliminary injunction was made therein

and the same was defended, and affidavits taken and filed, and the cause was heard, George Harding, A. Q. Keasbey and H. D. Donnelly, Esquires, appearing to contest the case for the defendants. And thereupon, after hearing, the Court made a decree and granted an injunction; afterwards said cause proceeded to final hearing, and the defendant and the said People's Telephone and Telegraph Company gave up further defence, and a final decree and a perpetual injunction were ordered and issued against the defendants.

The like proceedings were had, and like final decree and perpetual injunction issued in the same court against Andrew Albright, a licensee of said People's Telephone and Telegraph Company in said court. And thereafter, in the Circuit Court of the United States for the Southern District of New York, the complainants brought their bill in equity against said People's Telephone and Telegraph Company, and upon motion the Court granted an injunction therein, ordering the said company to desist from further infringement of the said two Bell patents.

25. All said injunctions and decrees still remain in full force and effect, and all said named defendants have, so far as the complainants are informed, entirely ceased to use or sell electric speaking telephones.

26. The apparatus used by the above-named defendants, the People's Telephone Company, the Eaton Telephone Company, and Spencer, Pearce & Jones, Lazelle, Harbert, Thau, Amos E. Dolbear, *et al.*, Ghegan and the People's Telephone and Telegraph Company, consisted of an electric speaking telephone apparatus, which employed what is known as a microphone or carbon transmitter as the transmitter member, and which employed what is known as a magneto telephone as the receiver member, except in the case of said Dolbear, who employed what is known as a condenser receiver for the receiving member. An apparatus consisting of a carbon transmitter and magneto receiver, as aforesaid, is substantially the apparatus employed by the defendants herein; and in and by the said decrees in said cases it was expressly decided and adjudged that a speaking telephone apparatus which employed the said instruments infringed the claims of the said patents, although

said instruments differed in their construction from that specifically shown in the drawings of the plaintiffs' patent.

And the complainants further show that the specific instruments used by the defendants in the said suits against the People's Telephone Company, the Eaton Telephone Company, and Spencer, Dolbear, *et al.*, Ghegan and the People's Telephone and Telegraph Company, exhibit changes and differences from those specifically described in the Bell patent, which changes and differences were themselves the subject of patents, and some of which are owned by the said respective defendants.

27. And your orators show that the telephones made by your said orator and the infringing telephones of the defendants are small instruments and easily concealed, and easily used in private, and easily transferred from one person to another, so that it is generally extremely difficult for your orators to detect all instances of such use, and extremely difficult to prove the use thereof by persons not licensed by your orators, and the extent of such use, and it would be extremely onerous and burdensome for your orators to bring separate suits against each user to restrain said infringing use; and so, if the defendants or either of them shall be allowed to continue to manufacture and supply such instruments for use during the pendency of this suit, your orators will be wholly without adequate remedy in the premises.

28. Yet the defendants, well knowing the premises and the exclusive rights of your orators as aforesaid, but contriving to injure your orators and to deprive them of the benefit and advantage which might and otherwise would accrue to them from said inventions, without the license or consent of your orators, and in infringement of the said patents, have, as your orators are informed and believe, jointly made, sold and used telephones embracing the inventions secured to your orator in said Letters Patent, or substantial and material parts of them, and have used the several improvements secured to your orator by said patents, and are still using the said improvements at New York City and divers other places within said district, and have furnished electric speaking telephones made by them to a considerable number of persons within this district, to be connected up and used as electric speaking telephones for the

transmission of articulate speech, by and according to the method secured to said Bell and to your orators by said patents, and still continue so to do; but precisely how long the defendants have made, sold and used the several improvements, and to what extent they have made, sold and used them, your orators, for want of a discovery thereof, do not know and cannot set forth, and they pray that the defendants may be compelled to set forth the same in their answer.

29. Your orators have requested the said defendants to acknowledge their rights in the premises, and to desist and refrain from the said acts, and from disregarding and infringing your orators' said rights, and to account with and pay to your orators what is justly due to your orators by reason of said infringement.

30. But now so it is, may it please your Honors, that the defendants wholly refuse so to do; but, on the contrary, continue and threaten to continue said infringement of the rights of your orators aforesaid, and particularly threaten to make and put out other like instruments, and thereby cause irreparable injury to your orators' lawful business. All of which is contrary to equity and good conscience.

31. To the end, therefore, that the said defendants may, if they can, show you why your orators should not have the relief herein prayed, and may upon their oaths and according to their best and utmost knowledge, remembrance, information or belief, full, true, direct and perfect answer make to all and singular the matters hereinbefore stated and charged, as fully and particularly as if the same were here repeated, and they especially interrogated as to each and every of said matters, and more especially may answer, discover and set forth, whether during any and what period of time, and whether at said New York or elsewhere, and when and where they used said improvements, or either of them; and whether they manufactured or sold any electric speaking telephones or apparatus to transmit speech by electricity, or the various parts of such telephones, and how many they have made or sold, and to whom they have sold the same, and how the said telephones and the several parts of the same are constructed and used; and particularly that the defendants and

each of them may upon his conscience and corporal oath answer th following interrogatories, and that on the part of the corporation defendant the same be answered by R. G. Dun, its president, or by its other chief executive officer and manager: —

1. State whether or not you, or either of your co-defendants within your knowledge, have made electric speaking telephones of any kind whatever in and by which speech uttered by the transmitting operator in the presence of the transmitting instrument is thence transmitted by means of electricity so that the same words spoken by him are heard by the listener to proceed from the receiving instrument; and if yea, state the construction and details of the instruments so made or procured to be made.

2. State whether or not you, or either of your co-defendants within your knowledge, have used, or procured to be used, electric speaking telephones of any kind whatever in and by which speech uttered by the transmitting operator in the presence of the transmitting instrument is thence transmitted by means of electricity, so that the same words spoken by him are heard by the listener to proceed from the receiving instrument; and if yea, state the construction and details of the instruments so used or procured to be used.

3. State whether you or either of your co-defendants within your knowledge have used or procured to be used by others, or have consented to or allowed the use of electrical telephonic apparatus between the premises No. 171 Broadway, New York City, and the premises Nos. 23 and 25 Dey Street, said city, by means of which apparatus words spoken in the presence of the transmitting member, and acting thereon cause the same words to be reproduced and heard by a person listening at the receiving member; and if so, when and how often, and describe the apparatus and the instruments which form the parts of it.

32. And your orators show that they are entitled to restrain all further use of telephones which have been or shall be manufactured and disposed of by the defendants or either of them, and to receive and collect from each user thereof a suitable sum as and for damages and profits in consequence of and growing out of such use by each person who has used the same; and not waiving said rights, but

wholly insisting thereon, and asserting that they intend to pursue and enforce said rights against said users, your orators aver that the defendants are also liable to pay to your orators other sums as and for profits by them actually realized by and from said infringement and unlawful acts. Wherefore your orators pray that the defendants may be decreed to account for and pay over to your orators all such gains and profits resulting to them from said infringements; and may be restrained, together with their servants and agents, by an injunction to be issued out of this honorable Court, or by one of your Honors, according to the law in such case provided, from making, selling and using the said improvements, patented as aforesaid, or either of them; and that they may be also enjoined and restrained as aforesaid, during the pendency of this suit, and for such other and further relief in the premises as the nature of the case may require and to your Honors shall seem meet.

33. May it please your Honors to grant unto your orators, not only a writ of injunction, but also a writ of *subpœna*, to be directed to the said defendants Overland Telephone Company, Robert G. Dun, Sylvanus C. Boynton, J. Newton Ewell, John W. Barrow, Erastus Wiman, Peter P. Pope, Jacob Moeser, Charles P. Crosby, and Seth R. Beckwith, commanding them and each of them at a certain time and under a certain penalty, therein to be limited, personally to be and appear before your Honors and this honorable Court, then and there to answer unto this bill of complaint, and to do and receive what to your Honors shall seem meet in the premises.

THE AMERICAN BELL TELEPHONE COMPANY.
By W. H. FORBES, *President.*

THE METROPOLITAN TELEPHONE AND TELEGRAPH COMPANY.
By GEO. N. VAIL, *President.*

UNITED STATES OF AMERICA.

STATE OF MASSACHUSETTS,
SUFFOLK COUNTY, ss.

APRIL 7, 1883.

Personally appeared W. H. Forbes, above named, and having been duly sworn, doth depose and say that he is president of the said American Bell Telephone Company, and of said Bell Telephone Company; that he has read the foregoing bill and knows the contents thereof; that all the matters therein stated as to the acts of said corporations he knows to be true; that all matters therein stated he believes to be true; and believes the said Bell to be the true, first and original inventor of the improvements in said two patents set forth and claimed; and that the same had not been in public use or on sale two years before his respec tive applications for said two patents.

Sworn to before me,

[SEAL] PHILIP S. STONE,
Notary Public for Suffolk County.

(Written on bottom of printed page 16.)

(Endorsed): U. S. Circuit Court, Southern Dist. of New York. American Bell Telephone Company *et al. v.* The Overland Telephone Company *et als.* Bill of Complaint. Dickerson & Dickerson, Complts' Solrs. New York City. U. S. Circuit Court. Filed Apr. 12, 1883.

TIMOTHY GRIFFITH,
Clerk.

IN THE CIRCUIT COURT OF THE UNITED STATES.

FOR THE SECOND CIRCUIT AND SOUTHERN DISTRICT OF NEW YORK.

IN EQUITY.

THE AMERICAN BELL TELEPHONE COMPANY AND THE METROPOLITAN TELEPHONE AND TELEGRAPH COMPANY, *Complainants.*

v.

THE OVERLAND TELEPHONE COMPANY, ROBERT G. DUN, SYLVANUS C. BOYNTON, I. NEWTON EWELL, JOHN W. BARROW, ERASTUS WIMAN, PETER P. POPE, JACOB MOESER, CHARLES P. CROSBY, AND SETH R. BECKWITH, *Defendants.*

To the Clerk of the Circuit Court of the United States, for the Second Circuit and Southern District of New York. In Equity:

Please enter the the appearance of the defendants, in the above-entitled action, by Charles P. Crosby, their solicitor.

Dated MAY 7th, 1883.

(sgd.) CHARLES P. CROSBY,
Solicitor for Defendants.

(Endorsed): In the Circuit Court of the United States, for the Second Circuit and Southern District of New York. The American Bell Telephone Company and The Metropolitan Telephone and Telegraph Company, complainants, *v.* The Overland Telephone Company, Robert G. Dun, Sylvanus C. Boynton, I. Newton Ewell, John W. Barrow, Erastus Wiman, Peter P. Pope, Jacob Moeser, Charles P. Crosby, and Seth R. Beckwith. Direction to Clerk to enter appearance of defendants. Charles P. Crosby, Solicitor for defendants, 160 Broadway, New York. U. S. Circuit Court. Filed, May 7, 1883.

TIMOTHY GRIFFITH,
Clerk.

ANSWER OF THE OVERLAND TELEPHONE COMPANY.

The separate Answer of the Overland Telephone Company, one of the above-named Defendants, to the Bill of Complaint of the American Bell Telephone Company, and the Metropolitan Telephone and Telegraph Company, Complainants.

This defendant, now and at all times hereafter saving and reserving to itself all manner and benefit of advantage and exception to the many errors and insufficiencies in the said bill of complaint contained, for answer thereto, or unto so much or such parts thereof as this defendant is advised is or are material or necessary for it to answer, this defendant separately answers and says: —

1. This defendant admits that Letters Patent of the United States of America, numbered 174,465, were granted and issued to Alexander Graham Bell, dated the seventh day of March, A. D. 1876, for an alleged improvement in telegraphy, as in said bill of complaint alleged.

2. This defendant admits that Letters Patent of the United States of America, numbered 186,787, were granted and issued to said Alexander Graham Bell, dated the thirtieth day of January, A. D. 1877, for an alleged invention in electric telegraphy, as in said bill of complaint alleged.

3. This defendant has no knowledge that the complainants' so-called corporations are duly established and authorized bodies corporate, or that either of them is a duly established and authorized body corporate, as in said bill alleged, and calls for due proof thereof.

4. This defendant has no knowledge of the several alleged assignments, grants, contracts and licenses referred to in said bill, by and through which the complainants pretend to have derived alleged rights from said Bell, directly or indirectly, as in the bill alleged, and calls for due proof of all and every thereof.

5. This defendant has no knowledge that the alleged inventions described in the said Letters Patent, or either of them, was or were

ever embodied in instruments known as the "Bell telephones" or in instruments known as "Blake transmitters," or in any of such instruments, as alleged in said bill, and therefore calls for due proof thereof.

6. On information and belief this defendant denies that said alleged inventions described and contained in the said several Letters Patent here in suit ever were, or either of them ever was, introduced into general and extensive use in public; and further, on information and belief, it says that the telephones heretofore introduced into general use as referred to in said bill were not of the same nor substantially the same construction and operation as the machines and instruments described in said Letters Patent, or in any or either of them, but were of substantially different construction and mode of operation, and were not the same, but substantially different inventions. And having no knowledge of the actual extent to which electric telephones have been up to the filing of said bill introduced into public use, it calls for due proof thereof, if such matter shall in any wise be or become material in this cause.

7. Save by hearsay and by the allegations of said bill, this defendant has no knowledge of the several suits alleged in the bill to have been instituted, nor of the several decrees or orders alleged to have been obtained or made therein, nor of any of the alleged proceedings therein, and therefore calls for due proof of all and every thereof; and, as advised by its counsel, defendant answers that if any such suit has been instituted, or any such decree or order has been obtained or made therein, or any such proceeding has been had therein, as in the complainants' bill alleged, the said alleged suits, proceedings, orders and decrees therein are, and each of them is, of no force or effect except as between the parties to said suit or suits and their privies.

8. Upon information and belief this defendant denies that the patents upon which this suit is brought are good and valid patents, or that either of them is a good and valid patent; it denies that the validity of them or of either of them has been generally recognized and acknowledged as in the bill alleged; and it denies that the claims of said Bell, of Gardiner G. Hubbard, of the complainants and of their predecessors, to the exclusive right to said alleged

inventions under said patents have been generally acknowledged and acquiesced in, as in the bill alleged.

Further answering on information and belief, this defendant says that not only has the validity of said patents and of the complainants' claims thereunder not been generally acknowledged and acquiesced in, but such fact is and has long been of great public notoriety; that it has long been notorious that Elisha Gray, of Chicago, Ill., Thomas A. Edison, of Menlo Park, N. J., Daniel Drawbaugh, of Eberly's Mills, Cumberland County, Penn., and others, have claimed and still do claim, each for himself, to be the original and first inventor of the inventions described, shown and claimed in said two Bell patents, and in each of them; that it has long been notorious that for years past interferences have been and now are pending undetermined in the Patent Office between said Bell, Gray, Edison and many others, to determine who is the original and first inventor of the matters described, shown and claimed in said two patents here in suit and in each of them respectively; and that it has long been and still is notoriously understood and believed that the owners of the said Bell patents, distrusting the ultimate result of said pending interferences, and fearing the decision or decisions of the Commissioner of Patents declaring said Bell not to be the original and first inventor of the inventions shown in his said patent or patents, have entered into an agreement and contract, or agreements and contracts, with said Gray, Edison and others, or with their assignees, in writing, providing for the contingency of a decision of the Commissioner of Patents adverse to said Bell in said interferences, and of decisions of the Court adverse to said Bell's claim as the original and first inventor of the matters claimed in his said patents or either of them, and arranged the terms and conditions upon which said Bell telephones shall be licensed by said Gray or by said Edison respectively, or by their respective assignees in the event that said Gray or said Edison shall be adjudged the original and first inventor thereof; and that the evidence of the said interferences and the proceedings therein, and of the exact terms, conditions and provisions of said contract or contracts between said Bell, Gray and Edison, or the respective owners of the alleged inventions claimed by said Bell, Gray and Edison respectively, is not in the possession

and control of these defendants or any of them, but of the said interfering applicants and patentees and their assignees, and of the parties to said contract or contracts, and can be obtained only by an examination of said persons or parties or by the order of this honorable Court.

9. Further answering upon information and belief, and as advised by its counsel, this defendant denies that the said first Bell patent, number 174,465, was or is a patent for any invention or improvement in electric speaking telephones, and says that, on the contrary, it was and is a patent for an improvement in electric telegraphs for the purpose of sending several messages simultaneously over the same wire; and that the said Alexander Graham Bell did not make his alleged invention of an electric speaking telephone until after the seventh day of March, 1876, the day on which said patent was granted. Further answering on information and belief, and as advised by its counsel, this defendant says that said last-named invention, if patented at all by said Bell, was patented in his Letters Patent numbered 186,787, granted on the thirtieth day of January, 1877, and not in any patent granted to him prior thereto.

10. Further answering on information and belief, and as advised by its counsel, this defendant denies that the said first Bell patent, numbered 174,465, is valid, and alleges and answers that it is invalid and void for the following reasons, to wit: —

A. Because the machine, instrument or alleged invention described, shown, contained and claimed therein is not a patentable invention, but is an inoperative, useless and worthless device.

B. Because the said Alexander Graham Bell was not the original and first inventor or discoverer of any material and substantial part of the thing patented; but, before his alleged invention or discovery thereof, the same or substantially the same thing or things had been invented and used by and were known to the following named persons of and at the following named places, to wit: —

Elisha Gray, of and at Chicago, in the county of Cook, and State of Illinois;

Thomas A. Edison, of and at the village of Menlo Park, in the State of New Jersey, and at the city of New York, in the State of New York;

Daniel Drawbaugh, of and at Eberly's Mills, in the county of Cumberland, and State of Pennsylvania;

James W. McDonald, of and at Chicago, in the county of Cook, in the State of Illinois;

A. E. Dolbear, of and at Somerville or Boston, in the State of Massachusetts;

George B. Richmond, of and at Washington, in the District of Columbia.

A. G. Holcombe, of and at New York, in the county of New York, in the State of New York.

C. Because in view of the state of the art at the time of the alleged invention of said Bell, the claims of said patent are too broad, covering inventions before made by others, and of which he was not, and his assigns are not, entitled to the exclusive use and enjoyment.

D. Because the said Bell, in obtaining the said patent, surreptitiously and unjustly obtained a patent for that which was, in fact, invented by another, to wit, said Elisha Gray, who was using reasonable diligence in adapting and perfecting the same.

E. Because the said Bell, in obtaining said patent, surreptitiously and unjustly obtained a patent for that which was, in fact, invented by another, to wit, said Thomas A. Edison, who was using reasonable diligence in adapting and perfecting the same.

F. Because the said Bell, in obtaining said patent, surreptitiously and unjustly obtained a patent for that which was, in fact, invented by another, to wits, aid Daniel Drawbaugh, who was using reasonable diligence in adapting and perfecting the same.

G. Because if the claims, or any of the claims, of the said patent numbered 174,465 is or are properly to be construed as sufficiently broad to cover electric speaking telephones, then said claim or claims so construed is or are substantially a claim or claims for a principle of nature or a necessary law of matter, which is not a proper or lawful subject for the grant of Letters Patent under the laws of the United States.

11. Further answering on information and belief, and as advised by its counsel, this defendant denies that the said second Bell

patent numbered 186,787 is valid, and alleges and answers that it is invalid and void for the following reasons, to wit: —

A. Because the machine, instrument or alleged invention described, shown, contained and claimed therein is not a patentable invention, but is an inoperative, useless and worthless device.

B. Because the said Alexander Graham Bell was not the original and first inventor or discoverer of any material and substantial part of the thing patented; but, before his alleged invention or discovery thereof, the same or substantially the same thing or things had been invented and used by, and were known to the following-named persons of and at the following-named places, to wit: —

Elisha Gray, of and at Chicago, in the county of Cook, and State of Illinois;

Thomas A. Edison, of and at the village of Menlo Park, in the State of New Jersey, and at the city of New York, in the State of New York;

Daniel Drawbaugh, of and at Eberly's Mills, in the county of Cumberland and State of Pennsylvania;

James W. McDonald, of and at Chicago, in the county of Cook, in the State of Illinois;

A. E. Dolbear, of and at Somerville or Boston, in the State of Massachusetts;

George B. Richmond, of and at Washington, in the District of Columbia;

A. G. Holcombe, of and at New York, in the County of New York, in the State of New York.

C. Because, in view of the state of the art at the time of the alleged invention of said Bell, the claims of said patent are too broad, covering inventions before made by others, and of which he was not, and his assigns are not, entitled to the exclusive use and enjoyment.

D. Because the said Bell, in obtaining said patent, surreptitiously and unjustly obtained a patent for that which was in fact invented by another, to wit, said Elisha Gray, who was using reasonable diligence in adapting and perfecting the same.

E. Because the said Bell, in obtaining said patent, surreptitiously and unjustly obtained a patent for that which was in fact invented

by another, to wit, said Thomas A. Edison, who was using reasonable diligence in adapting and perfecting the same.

F. Because the said Bell, in obtaining said patent, surreptitiously and unjustly obtained a patent for that which was in fact invented by another, to wit, said Daniel Drawbaugh, who was using reasonable diligence in adapting and perfecting the same.

12. This defendant on information and belief denies that it has ever infringed the said two patents numbered 174,465 and number 186,787, here in suit, or either of them, but further answering, says that it has become the owner, by assignments from Myron L. Baxter, of Aurora, Kane County, Illinois, of certain inventions in transmitting and receiving telephones described and shown in two several Letters Patent of the United States, granted to said Baxter, to wit, Letters Patent No. 277,198, dated May 8, 1883, for transmitting telephone, and Letters Patent No. 277,199, granted to said Baxter May 8, 1883, for receiving telephone; and that it has on a few occasions within two or three months last past privately, and merely for experimental and test purposes, operated a few of said Baxter instruments, but that it has never sold any of said instruments, nor put them on sale, nor put them into use for gain or profit or for any business purpose, nor for any other purpose than merely to test their novelty, working capacity and value, and to determine whether any, and, if so, what, further improvements could be made upon them, and to ascertain to the satisfaction of its experts and counsel whether the said Baxter telephones infringe any lawful or valid patent or patents heretofore granted to others.

13. This defendant, further answering, denies each and every allegation, statement and charge of the plaintiffs' bill of complaint, except such as are hereinabove specifically admitted to be true, and except such as are hereinabove expressly declared not to be within the knowledge or information of this defendant; and of all the latter it calls for due proof.

14. This defendant, answering the special interrogatories numbered 1, 2 and 3, required to be answered by the bill, makes answer thereto as follows: —

In answer to the interrogatory numbered 1, it says that it has caused to be made a few telephone instruments for the purposes of

experiment and test, as hereinabove set forth, and that said instruments were made, as this defendant believes, in exact accordance with the said two patents of Myron L. Baxter, numbered 277,198 and 277,199, copies of which patents are submitted herewith as part of this answer, and marked *Exhibit A* and *Exhibit B* respectively, and from which copies the construction and details of the instruments so made can be clearly understood.

In answer to the interrogatory numbered 2, this defendant says that it has not used nor procured to be used any other speaking telephones than those mentioned in this defendant's above answer to the interrogatory numbered 1.

In answer to the interrogatory numbered 3, this defendant says that the experimental use, which is referred to in this defendant's answer to the interrogatories numbered 1 and 2, took place in part between the premises No. 171 Broadway, New York City, and the premises Nos. 23 and 25 Dey Street in said city, and that it has neither used nor procured to be used by others, nor consented to or allowed the use of any electric telephone apparatus between the said premises, except as hereinabove set forth, and for the purposes of experiment and test, as above set forth, and for no other purpose whatever.

15. And this defendant denies all and all manner of unlawful combination and confederacy wherewith it is by the said bill charged; without this, that there is any other cause or thing in said complainants' said bill of complaint contained, material or necessary for this defendant to make answer unto and not herein and hereby well and sufficiently answered, confessed, traversed, avoided or denied, is true to the knowledge and belief of this defendant, all of which matters and things this defendant is ready and willing to aver, maintain and prove, as this honorable Court shall direct, and humbly prays to be hence dismissed, with its reasonable costs and charges in this behalf most wrongfully sustained.

THE OVERLAND TELEPHONE COMPANY,
by R. G. DUN, *President.*

CHAS. P. CROSBY,
Solicitor for defendant and of Counsel.

(Written on bottom of printed page 24.)

(Endorsed): United States Circuit Court, Southern District of New York. The American Bell Telephone Company & *al.* against The Overland Telephone Company & *al.* Separate Answer of The Overland Tel. Co. Charles P. Crosby, Solicitor for defendant. The Overland Tel. Co. N. Y. City. U. S. Circuit Court. Filed July 2, 1883. Timothy Griffith, Clerk.

Having thus described my invention, I claim as new—

1. In combination with an iron diaphragm arranged at right angles and in proximity to one pole of a permanent magnet, said magnet exerting an attractive influence at or near its center, an inducing-coil for varying the said attraction, composed partly of copper and partly of iron, for the purpose specified.

2. In combination with a vibrating iron diaphragm arranged at right angles, and its center in proximity to one pole of a permanent magnet and rigidly attached near its periphery to the other pole of the same magnet, an inducing-coil composed partly of iron and partly of copper, for the purpose specified.

3. In combination with a vibrating iron diaphragm, a cylindrical electro-magnet made up of convolutions of iron ribbon, the same being surrounded by a helix of copper wire and inclosing another helix of copper wire and one pole of a permanent magnet.

4. A compound inducing-coil consisting of a cylinder made up of a continuous insulated iron ribbon surrounded by a helix of copper wire, and acting by attraction upon a superposed iron diaphragm, and by electrical induction upon one pole of a permanent magnet located within said cylinder, substantially as described.

5. In combination with a vibrating iron diaphragm and a permanent magnet arranged at right angles thereto and exerting a magnetic attraction upon the same at or near its center, an inducing-helix of iron ribbon surrounding and in electrical connection with another inducing-helix of copper wire.

6. In combination with a permanently-magnetic core and an iron diaphragm, an inducing-coil consisting of two helices of insulated copper wire arranged concentrically, and having between them a helix of insulated iron ribbon, substantially as described, and for the purpose specified.

7. In combination with a vibrating iron diaphragm arranged at right angles, with its center in proximity to one pole of a permanent magnet and rigidly attached near its periphery to the other pole of the same magnet, an inducing-helix of iron ribbon surrounding and in electrical connection with another inducing-helix of copper wire.

8. In combination with a vibrating iron diaphragm and a permanent magnet arranged at right angles thereto and exerting a magnetic attraction upon the same at or near its center, an inducing-helix of iron ribbon surrounding and in electrical connection with another inducing-helix of copper wire, said helix of iron ribbon acting, by virtue of electric currents traversing its insulated convolutions, to vary the aforesaid magnetic attraction and at the same time to produce within its own substance a tubular electro-magnet.

In testimony whereof I affix my signature, in presence of two witnesses, this 21st day of December, 1882.

MYRON L. BAXTER.

Witnesses:
JAMES T. RICHARDSON,
D. G. DIXON.

H. E

UNITED STATES PATENT OFFICE.

MYRON L. BAXTER, OF AURORA, ILLINOIS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE OVERLAND TELEPHONE COMPANY.

RECEIVING-TELEPHONE.

SPECIFICATION forming part of Letters Patent No. 277,199, dated May 8, 1883.

Application filed December 22, 1882. (No model.)

To all whom it may concern:

Be it known that I, MYRON L. BAXTER, a citizen of the United States of America, residing at Aurora, in the county of Kane and State of Illinois, have invented certain new and useful Improvements in Receiving-Telephones, of which the following is a specification, reference being had therein to the accompanying drawings, in which—

Figure 1 is a vertical section of a receiving-telephone made in accordance with my invention. Fig. 2 is a plan view of the same with the ear-piece E removed. Fig. 3 is an enlarged vertical section of the coil and a part of the magnet, and shows a modification of the coil.

The several parts are indicated by the same letters in the different figures.

A is the stock or holder, made of wood, hard rubber, or any other suitable material, with ear-piece E, attached in any convenient manner, for clamping and securely holding by its periphery the vibrating iron diaphragm C.

B is a U shaped permanent magnet, to one leg, *b*, of which the aforesaid diaphragm C is attached by a screw, *c*. (Clearly shown in Fig. 1.) By this arrangement a stronger magnetic effect is produced between the pole *b'* and the diaphragm C.

D is the actuating or inducing coil, consisting of three concentric parts, *d*, *d'*, and *d''*, hereinafter more fully described.

e e are the connecting-wires connecting the parts *d* and *d''* with the binding-posts *a a*.

F is a set-screw for securely clamping and holding the magnet in place in the stock A at a proper distance from the vibrating diaphragm C. Currents of electricity entering and departing by the binding-posts *a a* actuate the compound inducing-coil D to produce audible vibration of the diaphragm.

The object of my invention is to provide a more perfect receiving-telephone, and one in which vocal sounds, including speech, shall not only be increased in volume, but also be rendered more clear, smooth, and natural. While my receiver may be used to advantage with ordinary transmitters, it is intended especially for use with a new form of battery-transmitter recently invented by me, whereof an application for Letters Patent is now pending; and the features of my invention which I believe to be new and which I claim are those belonging, essentially, to the compound actuating-coil D. This coil is made up as follows: its central portion, *d*, the part *d'*, of fine insulated iron wire or iron ribbon, and the part *d''*, of fine insulated copper wire. A current of electricity entering at one of the binding-posts and reaching first the outer end of the copper-wire coil *d''* traverses successively throughout all the convolutions of coils *d''*, *d'*, and *d*, passing from the latter to the other binding-post. The object of the iron coil *d'* is to afford, in addition to the central magnetic core, *b*, a tubular electro-magnet made up of the wire or ribbon itself, so that this coil, while it acts as an inducing-helix to the central magnetic core, is itself acted upon and rendered magnetic by the action of the copper-wire coil *d''*, and to a considerable extent reacts upon itself to produce the same result. Its effect upon the diaphragm is obvious—it amplifies the vibration. At Fig. 1 this portion of the coil is shown as wire, and in Fig. 3 as ribbon. The ribbon being merely a flattened wire, I regard the two as equivalents. In use I make the ribbon exceedingly thin, so as to get inductive effect from the current; but while more magnetic effect is obtained from the ribbon greater inductive effect is obtained from the wire. In either case it is to be understood that the material, be it ribbon or wire, is covered by an insulator.

With regard to my iron wire or ribbon coil, I do not wish to be understood as confining myself to soft iron, as steel may be used with advantage.

I am aware that a helix of copper wire without a core may in a manner be considered a magnet; but its magnetism is strongest in its vacant center, being due to the lines of force (so to speak) set up by electric currents, and not to the magnetic condition of the particles of the metal of which it is composed. The iron coil, however, becomes truly magnetic. It may here be remarked that the size of the iron wire used is greater than that of the copper, their cross-sectional areas being proportioned approximately to the relative conductivity of the metals.

(No Model.)

M. L. BAXTER.

RECEIVING TELEPHONE.

No. 277,199. Patented May 8, 1883.

Fig. 1.

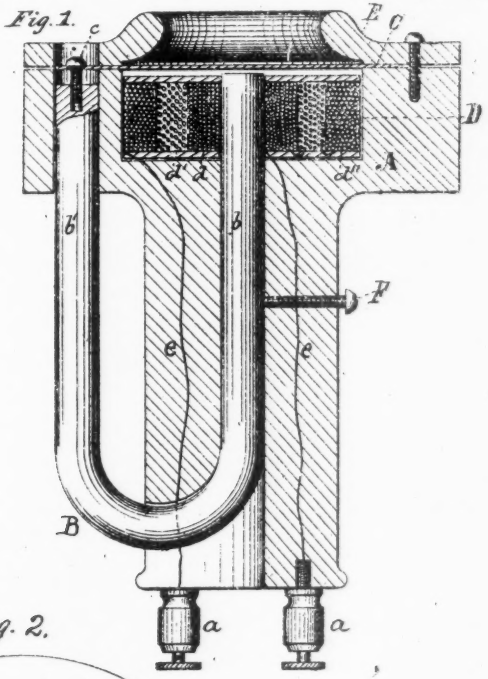


Fig. 2.

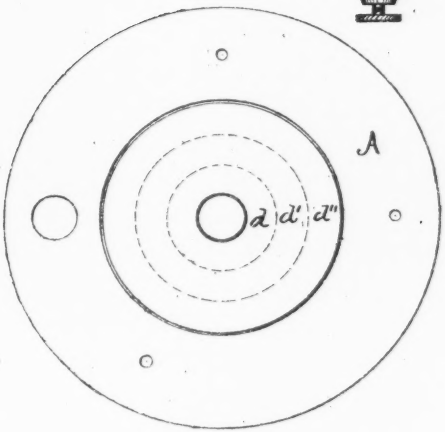
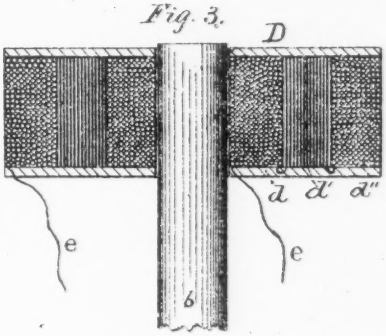


Fig. 3.



Witnesses:
W. C. Johnston.
Fred. F. Lehmuch.

Inventor:
Myron L. Baxter

adjusting device c c' c'', with the vibrating diaphragm carrying the other electrode, and the electro-magnetic controlling device, all operating substantially as described, and for the purpose specified.

2. The vibrating diaphragm carrying one of the electrodes, in combination with the suspended bar C, and the bolt c'', carrying the other electrode and the check-nut c, as and for the purpose specified.

3. The electro-magnetic controlling device operating in the manner described, in combination with the suspended bar C, the bolt c'', carrying one electrode and the check-nut c, and the vibrating diaphragm carrying the other electrode, as and for the purpose specified.

4. The bolt c'', carrying the carbon button d and the check-nut c, in combination with the suspended bar C, as and for the purpose described.

In testimony whereof I affix my signature, in presence of two witnesses, this 4th day of December, 1882.

MYRON L. BAXTER.

Witnesses:
JAMES T. RICHARDSON,
D. G. DIXON.

with relation to the bar C that when the electro-magnetic controller E F is not exerting any attraction the contact between the electrodes shall be by gravity very slight and just sufficient to establish the current through the helix F, the bolt c'' is screwed in or out of the bar C, carrying with it the nut c' and the attached carbon button d, and the nut c is then turned down to act as a check-nut for holding it firmly in position. This contact should be, as stated, slight, and should be regulated after the transmitter box or case is secured in position.

The operation of my invention is as follows: Supposing a given current from the battery to be flowing, the attractive force exerted upon D by E will cause a firm contact between p and d, which will be approximately the mean of pressure or of surface-contact. If now a heavy impulse thrusts forward the stud p against d, the result will be quite different from that observed when the suspended bar B is held in place merely by gravity or by a spring. Instead of being carried away by its momentum, thus breaking the circuit, the bar C is held in closer contact by the increased attractive force of core E, such increased attractive force being due to a stronger current operating upon it, and such stronger current is obtained by the increased contact between p and d by the thrust of p against d. For this reason more ample vibration can be given to the diaphragm without "breaking." The pressure, however, at the end of the excursion is considerably less than that quickly succeeding the initial thrust, the then greatly-increased attractive force of E having been to a great extent overcome by the momentum of C; but enough force still remains in E to secure, on the retreat of the diaphragm and stud p, actual contact. This contact, however, rapidly diminishes almost to the point of disruption at the extreme point of retreat, as will be understood by considering the mutual action of pressure between the electrodes and attractive force of core E, one acting upon the other and being in turn acted upon by the other. In practice I find that a proper relation (easily determined by experiment) between the battery, the coil F, and the space between E and D gives a combination by which very loud sounds are perfectly transmitted, and also one by which the faintest are also sent to line with equal facility, and this without further adjustment. To provide, however, for different conditions of the battery, I make the core E movable within the coil F, so that it may, at will and without opening the transmitter-box, be adjusted at a greater or less distance from D.

By my transmitting-telephone telephony through very long lines, heretofore impossible, is rendered practicable; and upon short lines a great advantage in distinctness and volume of tone is obtained, the vibration of the diaphragm in an ordinary receiving-telephone being so greatly amplified as to be distinctly heard at a distance of several feet. Even better results are obtained from receiving-telephones constructed with special reference to the duty required. The reason of this marked superiority is in the fact that a stronger induced current is derived from the greater range of variation in the primary current from the battery.

It should, perhaps, be clearly stated that I use a stronger battery than is used ordinarily or can in ordinary transmitters be used to advantage, for the following reasons: As the induced current sent to line has a strength proportioned to the degree of variation in the battery-current, it is clear that the induced current due to a battery of ten volts varied to nine volts would be no more powerful than one due to a battery of two volts varied to one volt. It is also clear that the induced current due to a battery of five volts varied to one volt would be much more powerful than one due to a battery of ten volts varied only to nine volts.

It will be observed that the electro-magnetic attraction governing the pressure between the electrodes is not exerted directly upon the diaphragm, but upon a freely-suspended bar carrying one of the electrodes; also that the attraction is exerted upon the longer arm of a lever of the second kind, the pressure thereby being multiplied. By this arrangement a helix opposing less resistance to the battery-current can be used than would be the case were the pressure applied direct, as less attractive force is required to produce the same pressure.

The use of permanent magnets acting by attraction or repulsion to control to a certain extent the movements of the electrodes is not new, and is objectionable for the reason that when not provided with an inducing-coil said magnets exert a constant force like that due to a spring or to gravity; and even when furnished with an inducing-coil they do not act as completely and powerfully as a soft-iron core, because, as is well known, a steel bar, whether used as a core or an armature, cannot be as powerfully acted upon by a coil, and also because the difference in magnetic tension under wide variations in the battery-current cannot be as great as with a soft-iron core whose power has a range from maximum to zero.

Another important difference lies in the fact that the electro-magnetic core is not in contact with any of the moving parts of the transmitter, and when once brought to a proper adjustment remains stationary. As with this arrangement I do not utilize any motion of the core to act inductively (electrically) upon a secondary wire, my primary helix is wound next to the core, thereby realizing its maximum effect; and by placing my electrode upon a disconnected part I am able to make of my electro-magnet the primary of an efficient induction-coil.

Having thus fully described my invention, I claim as new the following:

1. The combination of the suspended bar C, carrying one of the electrodes attached to the

UNITED STATES PATENT OFFICE.

MYRON L. BAXTER, OF AURORA, ILLINOIS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE OVERLAND TELEPHONE COMPANY.

TRANSMITTING-TELEPHONE.

SPECIFICATION forming part of Letters Patent No. 277,198, dated May 8, 1883.

Application filed December 9, 1882. (No model.)

To all whom it may concern:

Be it known that I, MYRON L. BAXTER, a citizen of the United States of America, residing at Aurora, in the county of Kane and State of Illinois, have invented certain new and useful Improvements in Transmitting-Telephones, of which the following is a specification, reference being had therein to the accompanying drawings.

The object of my invention is to provide means whereby the limit of variation in the strength of a voltaic current may be greater than at present. This refers to the undulatory current used for generating a current for the transmission of speech telephonically, and which, as is well known, is the result of a variation gradual in its nature from strong to weak, and vice versa. When the current sent to line is due to magnetic induction from a permanent magnet the variation to which it owes its existence is effected by strengthening or weakening said magnet; but when said current is derived from a galvanic battery by induction the variation is produced in the primary or direct battery-current. To the latter class my invention pertains.

In common with other transmitters I use in mine the vibrating diaphragm carrying or actuating a metallic stud in unstable contact with a piece of hard or soft carbon or carbonaceous material, which is attached to a freely-suspended bar, and an induction-coil for producing the intense induced secondary current; and these, either singly or in combination in their well-known forms, I do not claim.

In all the battery-transmitters with which I am acquainted the limit of variation is very narrow, and consequently the strength of the induced current is small.

My object is, as hereinbefore set forth, to increase the variation, (without actually breaking the circuit,) and consequently to send to line a much more powerful induced or secondary current to work upon the distant receiving-telephone, overcoming resistance, leaks, and extraneous induction incident to long lines. To effect this I make use of the devices shown in the accompanying drawings, in which—

Figure 1 is a plan view of the inside of the door of the transmitter. Fig. 2 is a vertical section of the door through the line *z z*, Fig. 1. Fig. 3 is a vertical section of the induction-coil through line *x x*, Fig. 2.

A is the door of the transmitter; *a*, the orifice through which the sounds to be transmitted obtain access to the diaphragm B, which is surrounded at its periphery by the soft-rubber binding *b'''*, and is held in position by the clip *b'* and the presser-spring *b*, with its soft-rubber-covered end *b''*. From the block *h* is suspended, from the pointed screws *j j*, (passing through threaded lugs *i i*,) the swinging bar C, carrying the carbon button *d*, nuts *c* and *c'*, and the bolt *c''*. From the center of the diaphragm projects the metallic stud *p* in unstable contact by gravity with the carbon button *d*. The suspended bar C may be of soft iron throughout its entire length, or of other magnetic material, or, as is shown, it may be terminated only with the soft iron or other magnetic material D.

E, F, and G represent the induction-coil, which, in addition to its ordinary function, serves, as hereinafter fully described, to vary the pressure between the metal stud *p* and the carbon button *d*. One pole of the battery (which is not shown) is connected to the butt or hinge *m* and the other to the hinge *n*, the course of the current being from *n* to *f'*, thence through the convolutions of the primary coil F, thence to *f*, thence through the metal diaphragm B to the metallic stud *p*, (or, if a non-conducting diaphragm be used, by a wire connecting *f* with *p*,) and thence to the battery through the carbon button *d*, the suspended bar B, the pointed screw *j*, the lug *i*, and the hinge *m*.

The secondary coil G is wound upon the primary coil F for economic reasons. It may be disregarded if a complete induction-coil, properly connected with the line, be introduced into the primary circuit between either of the hinges and the battery. With the secondary coil G removed, we have simply a straight electro-magnet, E F, included in the circuit and controlling the pressure between the electrodes *p d*.

In order to so adjust the carbon button *d*

(No Model.)

M. L. BAXTER.

TRANSMITTING TELEPHONE.

No. 277,198. Patented May 8, 1883.

Fig. 2.

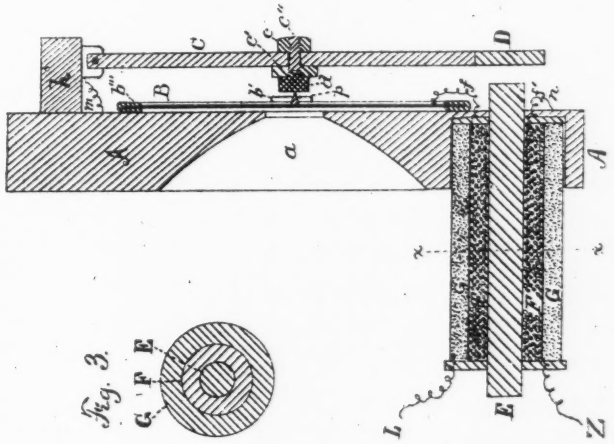
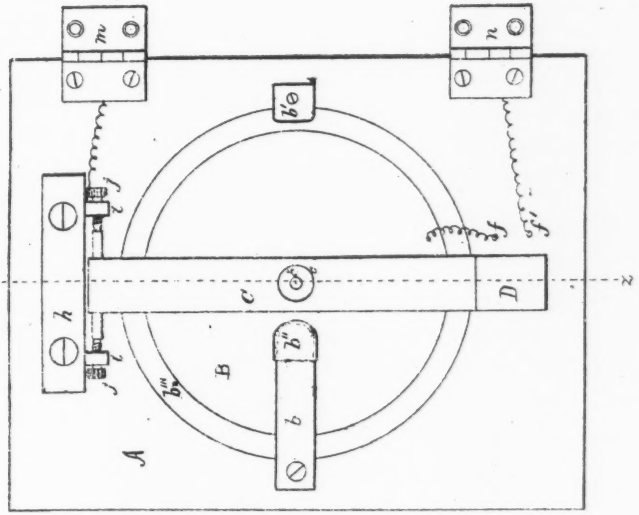


Fig. 3.

Fig. 1.



Witnesses:
James T. Richardson
Olof Dixon

Inventor:
Myron L. Baxter

UNITED STATES OF AMERICA.

STATE OF NEW YORK,
COUNTY OF NEW YORK, ss.

Personally appeared before the undersigned, a notary public in and for said County and State, Robert G. Dun, who, being duly sworn, says, that he is president of said "The Overland Telephone Company"; that he has read the foregoing answer by him subscribed, and knows the contents thereof; that all the matters therein stated as the acts of said corporation he knows to be true, and that all other matters therein stated he believes to be true.

R. G. DUN, *President.*

Sworn to and subscribed before me this twenty-eighth day of June, 1883.

WM. THORP,
Notary Public Kings Co.

Certificate filed in N. Y. Co.

REPLICATION.

The Replication of the above-named Complainants to the separate Answer of The Overland Telephone Company, one of the above-named Defendants.

These repliants, saving and reserving unto themselves all and all manner of advantage of exception to the manifold insufficiencies of the said answer, for replication thereunto, say that they will aver and prove their said bill to be true, certain and sufficient in the law to be answered unto, and that the said answer of the defendants is uncertain, untrue and insufficient to be replied unto by these repliants; without this, that any other matter or thing whatsoever in the said answer contained, material or effectual in the law to be replied unto, confessed and avoided, traversed or denied, is true.

All which matters and things these repliants are and will be ready to aver and prove as this honorable Court shall direct, and humbly pray as in and by their said bill they have already prayed.

DICKERSON & DICKERSON,
Complainants' Solicitors.

(Written on bottom of printed page 25.)

(Endorsed): U. S. Circuit Court. Southern Dist. of N. Y. The American Bell Tel. Co. & *al.* *v.* The Overland Tel. Co. Replication to the Separate Answer of The Overland Telephone Company. U. S. Circuit Court. Filed August 6, 1883. Timothy Griffith, Clerk.

ANSWER OF ROBERT G. DUN.

The separate Answer of Robert G. Dun, one of the above-named Defendants, to the Bill of Complaint of the American Bell Telephone Company and the Metropolitan Telephone and Telegraph Company, Complainants.

This defendant, now and at all times hereafter saving and reserving to himself all manner and benefit of advantage and exception to the many errors and insufficiencies in the said bill of complaint contained, for answer thereto, or unto so much or such parts thereof as he is advised is or are material or necessary for him to answer, he separately answers and says: —

1. He admits the issue of the complainants' patents as stated in the bill of complaint.

2. He denies that he has ever infringed said patents, or either of them.

3. He denies all and all manner of unlawful confederacy or conspiracy with other parties, as charged in the bill of complaint.

4. He has no knowledge whether any of the complainants, or either of them, is legally or duly incorporated, and calls for due proof thereof.

5. He has no knowledge whether the said patents numbered 174,465 and numbered 186,787 are, or either of them is, the exclusive property of the complainants, or either of them, and calls for due proof thereof.

6. He denies on information and belief the validity of both and each of said two patents here in suit for the following reasons, to wit: —

(1.) Because said Bell was not the first and original inventor or discoverer of any material or substantial part of the things patented, or either of them, but the same thing or things had been, before his supposed invention and discovery thereof, invented by and known to Daniel Drawbaugh, of and at Eberly's Mills, in the county of Cumberland and State of Pennsylvania; invented by and known to Elisha Gray, of and at Chicago, in the county of Cook and State of Illinois; invented by and known to Thomas A. Edison, of and

at Menlo Park, in the State of New Jersey, and in the city of New York and State of New York; invented by and known to James W. McDonald, of and at the city of Chicago, in the State of Illinois; invented by and known to A. E. Dolbear, of and at Somerville or Boston, in the State of Massachusetts; invented by and known to George B. Richmond, of and at Washington, in the District of Columbia; invented and known to A. G. Holcombe, of and at New York, in the county of New York, and State of New York.

(2.) Because said Bell surreptitiously and unjustly obtained by them and each of said two patents here in suit a patent or patents for that which was in fact invented by others, to wit, said Elisha Gray, said Thomas A. Edison, said Daniel Drawbaugh, said James W. McDonald, said A. E. Dolbear, said A. G. Holcombe and said George B. Richmond, respectively, who were each using reasonable diligence in adapting and perfecting the same, and each of the same inventions.

7. As to all other matters or things stated or charged in the bill of complaint, and not hereinabove expressly referred to and specifically answered, this defendant adopts the answer filed in this cause by the Overland Telephone Company, which he believes to be true, and prays that it may be read in connection with this answer and as part hereof.

8. And this defendant denies all and all manner of unlawful combination and confederacy wherewith he is by said bill charged; without this, that there is any other cause or thing in said complainants, said bill of complaint contained material or necessary for this defendant to make answer unto, and not herein and hereby well and sufficiently answered, confessed, traversed, avoided or denied, is true to the knowledge and belief of this defendant, all of which matters and things this defendant is ready and willing to aver, maintain and prove as this honorable Court shall direct, and humbly prays to be hence dismissed with his reasonable costs and charges in this behalf most wrongfully sustained.

R. G. DUN.

CHAS. P. CROSBY,
Solicitor for Defendants and of Counsel.

(Written on bottom of printed page 34.)

(Endorsed): U. S. Circuit Court. S. D. of N. Y. The American Bell Telephone Co. & *al.* *v.* The Overland Telephone Co. & *al.* Separate Answer of Robert G. Dun. Charles P. Crosby, Solicitor for defendant. Robert G. Dun. N. Y. City. U. S. Circuit Court. Filed July 2, 1883. Timothy Griffith, Clerk.

UNITED STATES OF AMERICA.

STATE OF NEW YORK,
COUNTY OF NEW YORK, ss.

Personally appeared before the undersigned, a notary public in and for said county and State, the above-named Robert G. Dun, who, being duly sworn, deposes and says, that he has read the foregoing answer by him subscribed, and knows the contents thereof; that all the matters therein stated of his own knowledge are true, and that all matters therein stated on information and belief he believes to be true.

R. G. DUN.

Sworn to and subscribed before me this twenty-eighth day of June, 1883.

WM. THORP,
Notary Public Kings Co.

Certificate filed in N. Y. Co.

[NOTE. Each of the defendants, Boynton, Ewell, Barrow, Wiman, Crosby and Beckwith, filed a separate sworn answer similar in terms to the above answer of Robert G. Dun.]

ANSWER OF PETER P. POPE.

The separate Answer of Peter P. Pope, one of the above-named Defendants to the Bill of Complaint of the American Bell Telephone Company and the Metropolitan Telephone and Telegraph Company, Complainants.

This defendant, now and at all times hereafter saving and reserving to himself all manner and benefit of advantage and exception to the many errors and insufficiencies in the said bill of complaint contained, for answer thereto, or unto so much or such parts thereof as he is advised is or are material or necessary for him to answer, he separately answers and says: —

1. He denies that he has ever infringed the patents or either of the patents of the complainants mentioned in the bill of complaint, or made, sold or used, or authorized others to make, sell or use, any

telephone or telephones whatever. And further answering says, that he was one of the incorporators of the defendant, the Overland Telephone Company, but that long prior to the commencement of this suit and before said company had acquired or become the owner of any right, title or interest in any telephone or telephones, or any patent or patents for any telephone or telephones, or made, operated or dealt in the same or either of the same, to wit, on the eighth day of March, 1883, he transferred all his right, title, interest, claim and demand in and to said company, its property, assets and stock, and thereupon ceased to have any interest therein, and has not now, and since said eighth day of March, 1883, has not had any interest in said company, its property, assets or stock.

2. As to all other matters and things stated or charged in the bill of complaint not herein answered, this defendant denies any knowledge or information sufficient to form a belief, and leaves complainants to make due proof thereof.

3. This defendant, answering the special interrogatories numbered 1, 2 and 3, required to be answered by the said bill, makes answer thereto as follows: —

(1.) In answer to the interrogatory numbered 1 he says that he has not made electric speaking telephones of any kind whatever at any time or place, and has no knowledge that any of his co defendants have made any electric speaking telephones of any kind whatever at any time or place.

(2.) In answer to the interrogatory numbered 2, he says that he has not used nor procured to be used electric speaking telephones of any kind whatever at any time or place, and has no knowledge that any of his co-defendants have ever used or procured to be used electric speaking telephones of any kind whatever.

(3.) In answer to interrogatory numbered 3, he says that he has not used nor procured to be used by others, or consented to or allowed the use of electrical telephonic apparatus between the premises 171 Broadway, New York City, and the premises Nos. 23 and 25 Dey Street, New York City, and has no knowledge that any of his co-defendants have used or procured to be used by others, or consented to or all wed the use of said apparatus between said premises.

4. And this defendant denies all and all manner of unlawful combination and confederacy wherewith he is by said bill charged; without this, that there is any other cause or thing in said complainants' said bill of complaint contained, material or necessary for this defendant to make answer unto and not herein and hereby well and sufficiently answered, confessed, traversed, avoided or denied, is true to the knowledge and belief of this defendant, all of which matters and things this defendant is ready and willing to aver, maintain and prove as this honorable Court shall direct, and humbly prays to be hence dismissed with his reasonable costs and charges in this behalf most wrongfully sustained.

PETER P. POPE.

CHAS. P. CROSBY,
Solicitor for Defendants and of Counsel,
160 Broadway, New York City.

UNITED STATES OF AMERICA.

STATE OF NEW YORK,
COUNTY OF NEW YORK, ss.

Personally appeared before the undersigned, a notary public in and for said county and State, the above-named Peter P. Pope, who being duly sworn deposes and says: That he has read the foregoing answer by him subscribed and knows the contents thereof, that all the matters therein stated of his own knowledge are true, and that all matters therein stated on information and belief he believes to be true.

PETER P. POPE.

Sworn to and subscribed before me this twenty-ninth day of June, 1883.

WM. THORP,
Notary Public Kings Co.

Certificate filed in N. Y. Co.

[NOTE. Jacob Moeser, one of the above-named defendants, filed a separate sworn answer similar in terms to the answer of Peter P. Pope.]

3 L

REPLICATION.

The Replication of the above-named Complainants to the separate Answer one of the above-named Defendants.

These repliants, saving and reserving unto themselves all and all manner of advantage of exception to the manifold insufficiencies of the said answer, for replication thereunto say that they will aver and prove their said bill to be true, certain and sufficient in the law to be answered unto, and that the said answer of the defendant is uncertain, untrue and insufficient to be replied unto by these repliants; without this, that any other matter or thing whatsoever in the said answer contained, material or effectual in the law to be replied unto, confessed and avoided, traversed or denied, is true.

All which matters and things these repliants are and will be ready to aver and prove as this honorable Court shall direct, and humbly pray as in and by this said bill they have already prayed.

DICKERSON & DICKERSON,
Complainants' Solicitors.

[NOTE. Separate replications as above were filed to the separate answers of John W. Barrows, Peter S. Pope, Robert G. Dun, Jacob Moeser, J. Newton Ewell, Sylvanus C. Boynton, Charles P. Crosby, Seth R. Beckwith and Erastus Wiman.]

(Written on bottom of printed page 37.)

(Endorsed): U. S. Circuit Court. Southern Dist. of N. Y. The American Bell Tel. Co & *al. v.* The Overland Tel. Co. & *al.* Separate Answers of Peter P. Pope. Charles P. Crosby, Sol'r for deft. Peter P. Pope. N. Y. City. U. S. Circuit Court. Filed July 2, 1883. Timothy Griffith, Clerk.

(Written on bottom of printed page 38.)

(Endorsed): U. S. Circuit Court. Southern Dist. of N. Y. The American Bell Telephone Co. & *al.* *v.* The Overland Telephone Co. & *al.* Replication to the Separate Answer of Peter P. Pope. Dickerson & Dickerson, Complts' Sol'rs. N. Y. City. U. S. Circuit Court. Filed Aug. 6, 1883. Timothy Griffith, Clerk.

EVIDENCE FOR COMPLAINANTS.

TAKEN PURSUANT TO THE SIXTY-SEVENTH RULE OF THE SUPREME COURT OF THE UNITED STATES IN EQUITY AS AMENDED, BEFORE ME,

CHAS. H. SWAN, *Special Examiner.*

---

40 STATE ST., BOSTON, MASS.,
Nov. 28, 1883.

Present: JAMES J. STORROW, Esq., *and* GEORGE L. ROBERTS, Esq., *of Counsel for Complainants;*
S. S. HOLLINGSWORTH, Esq., *of Counsel for such Defendants as have appeared.*

Counsel for complainants put in evidence: —

1. A certified copy of Letters Patent No. 174,465, granted Alexander Graham Bell, March 7, 1876, which is marked "*Exhibit Bell Patent No.* 174,465, *Chas. H. Swan, Examiner.*"

2. A certified copy of Letters Patent No. 186,787, granted Alexander Graham Bell, Jan. 30, 1877, which is marked "*Exhibit Bell Patent No.* 186,787, *Chas. H. Swan, Examiner.*"

3. Certified copies of the following assignments: (1) Alexander Graham Bell to Gardiner G. Hubbard, dated July, 1877, and recorded July 28, 1877, Liber R^{21}, page 399; (2) Gardiner G. Hubbard to the Bell Telephone Company, dated July 20, 1878, and recorded Oct. 3, 1878, Liber Y^{22}, page 460; (3) Bell Telephone Company to the American Telephone Company, dated June 22, 1880, and recorded June 22, 1880, Liber I^{25}, page 282; and the same are marked "*Exhibit Assignments, Chas. H. Swan, Examiner.*"

[*Counsel for defendants objects to all these certified copies of assignments as not being the best evidence, and objects to the assignment signed by Gardiner G. Hubbard, Trustee, because it does not appear that he had any power to convey; and objects to the assignment from the Bell Telephone Company to the American Bell because no title has been shown in the Bell Company.*]

4. A certified copy of the charter of the American Bell Telephone Company, and also a certified copy of the Certificate of Incorporation of the American Bell Telephone Company, and also a certified copy of the last clause of section 11, Chap. 224, of the Acts of 1870, of the Commonwealth of Massachusetts, and the same are marked "*Exhibit Complainants' Incorporation.*"

[*Counsel for defendants objects to the certificate of incorporation on the ground that the certificate of the Secretary of the Commonwealth is no evidence at all whether the law is in force or not.*]

5. A certified copy of the final decree in the equity case of American Bell Telephone Company *et al. v.* Albert L. Spencer, in the United States Circuit Court for the District of Massachusetts, and the same is marked "*Exhibit Decree in Spencer Case.*"

[*Counsel for defendants objects to this exhibit, first, as being immaterial, because from a suit to which the defendant was not a party; and second, because if immaterial the complainant cannot put a fragment of a record in evidence, but is bound to put in the whole record.*]

TELEGRAPHY.

No. 174,465. Patented March 7, 1876

Fig. 1.

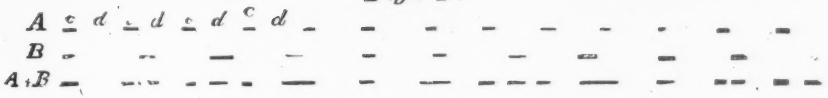


Fig. 2.

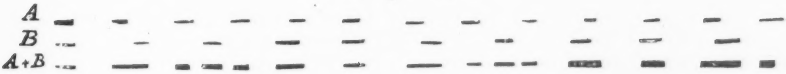


Fig. 3

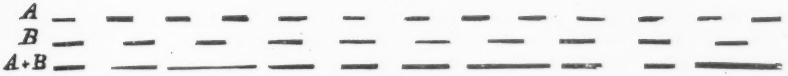


Fig. 4.

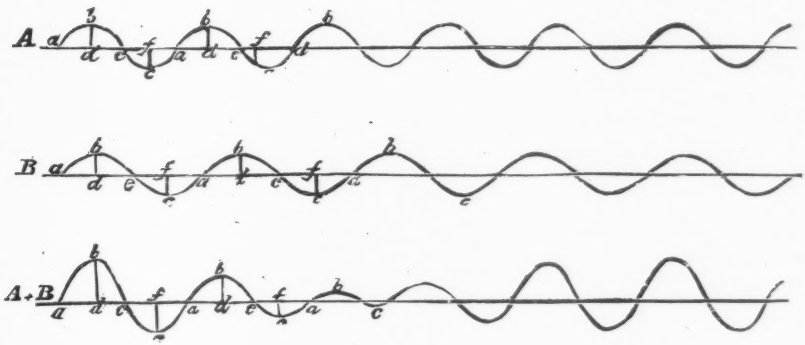
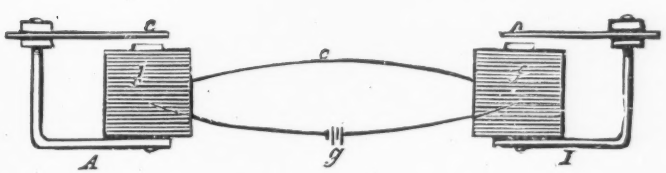


Fig. 5.



Witnesses:

Ewell & Hack

W. J. Hinkle

Inventor:

A. Graham Bell

by attys. Pollock & Bailey

No. 174,465. Patented March 7, 1876.

Fig. 6.

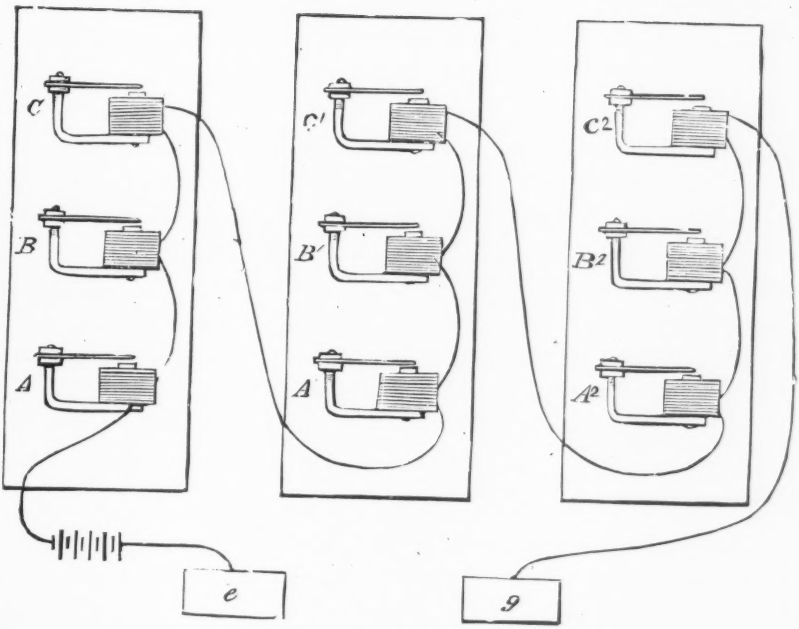
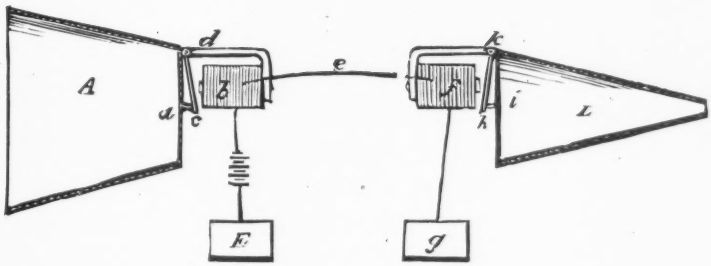


Fig. 7



Witnesses:

Ewell & Stock,
H. J. Hunteman

Inventor:

A. Graham Bell
by atty's Pollok & Bailey

UNITED STATES PATENT OFFICE.

ALEXANDER GRAHAM BELL, OF SALEM, MASSACHUSETTS.

IMPROVEMENT IN TELEGRAPHY.

Specification forming part of Letters Patent No. 174,465, dated March 7, 1876; application filed Febuary 14, 1876.

To all whom it may concern:

Be it known that I, ALEXANDER GRAHAM BELL, of Salem, Massachusetts, have invented certain new and useful Improvements in Telegraphy, of which the following is a specification: —

In Letters Patent granted to me April 6, 1875, No. 161,739, I have described a method of, and apparatus for, transmitting two or more telegraphic signals simultaneously along a single wire by the employment of transmitting instruments, each of which occasions a succession of electrical impulses differing in rate from the others; and of receiving instruments, each tuned to a pitch at which it will be put in vibration to produce its fundamental note by one only of the transmitting instruments; and of vibratory circuit-breakers operating to convert the vibratory movement of the receiving instrument into a permanent make or break (as the case may be) of a local circuit, in which is placed a Morse sounder, register, or other telegraphic apparatus. I have also therein described a form of autograph-telegraph based upon the action of the above-mentioned instruments.

In illustration of my method of multiple telegraphy I have shown in the patent aforesaid, as one form of transmitting instrument, an electro-magnet having a steel-spring armature, which is kept in vibration by the action of a local battery. This armature in vibrating makes and breaks the main circuit, producing an intermittent current upon the line-wire. I have found, however, that upon this plan the limit to the number of signals that can be sent simultaneously over the same wire is very speedily reached; for, when a number of transmitting instruments, having different rates of vibration, are simultaneously making and breaking the same circuit, the

effect upon the main line is practically equivalent to one continuous current.

In a pending application for Letters Patent, filed in the United States Patent Office Feburary 25, 1875, I have described two ways of producing the intermittent current — the one by actual make and break of contact, the other by alternately increasing and diminishing the intensity of the current without actually breaking the circuit. The current produced by the latter method I shall term, for distinction sake, a pulsatory current.

My present invention consists in the employment of a vibratory or undulatory current of electricity in contradistinction to a merely intermittent or pulsatory current, and of a method of, and apparatus for, producing electrical undulations upon the line-wire.

The distinction between an undulatory and a pulsatory current will be understood by considering that electrical pulsations are caused by sudden or instantaneous changes of intensity, and that electrical undulations result from gradual changes of intensity exactly analogous to the changes in the density of air occasioned by simple pendulous vibrations. The electrical movement, like the aerial motion, can be represented by a sinusoidal curve or by the resultant of several sinusoidal curves.

Intermittent or pulsatory and undulatory currents may be of two kinds, accordingly as the successive impulses have all the same polarity or are alternately positive and negative.

The advantages I claim to derive from the use of an undulatory current in place of a merely intermittent one are, first, that a very much larger number of signals can be transmitted simultaneou-ly on the same circuit; second, that a closed circuit and single main battery may be used; third, that communication in both directions is established without the necessity of special induction-coils; fourth, that cable despatches may be transmitted more rapidly than by means of an intermittent current or by the methods at present in use; for, as it is unnecessary to discharge the cable before a new signal can be made, the lagging of cable-signals is prevented; fifth, and that as the circuit is never broken a spark-arrester becomes unnecessary.

It has long been known that when a permanent magnet is caused

to approach the pole of an electro-magnet a current of electricity is induced in the coils of the latter, and that when it is made to recede a current of opposite polarity to the first appears upon the wire. When, therefore, a permanent magnet is caused to vibrate in front of the pole of an electro-magnet an undulatory current of electricity is induced in the coils of the electro-magnet, the undulations of which correspond, in rapidity of succession, to the vibrations of the magnet, in polarity to the direction of its motion, and in intensity to the amplitude of its vibration.

That the difference between an undulatory and an intermittent current may be more clearly understood I shall describe the condition of the electrical current when the attempt is made to transmit two musical notes simultaneously — first upon the one plan and then upon the other. Let the interval between the two sounds be a major third; then their rates of vibration are in the ratio of 4 to 5. Now, when the intermittent current is used the circuit is made and broken four times by one transmitting instrument in the same time that five makes and breaks are caused by the other. A and B, Figs. 1, 2, and 3, represent the intermittent currents produced, four impulses of B being made in the same time as five impulses of A. *c c c*, &c., show where and for how long time the circuit is made, and *d d d*, &c., indicate the duration of the breaks of the circuit. The line A and B shows the total effect upon the current when the transmitting instruments for A and B are caused simultaneously to make and break the same circuit. The resultant effect depends very much upon the duration of the make relatively to the break. In Fig. 1 the ratio is as 1 to 4; in Fig. 2, as 1 to 2; and in Fig. 3 the makes and breaks are of equal duration. The combined effect, A and B, Fig. 3, is very nearly equivalent to a continuous current.

When many transmitting instruments of different rates of vibration are simultaneously making and breaking the same circuit the current upon the main line becomes for all practical purposes continuous.

Next, consider the effect when an undulatory current is employed. Electrical undulations, induced by the vibration of a body capable of inductive action, can be represented graphically, without error, by the same sinusoidal curve which expresses the vibration of the

inducing body itself, and the effect of its vibration upon the air; for, as above stated, the rate of oscillation in the electrical current corresponds to the rate of vibration of the including body — that is, to the pitch of the sound produced. The intensity of the current varies with the amplitude of the vibration — that is, with the loudness of the sound; and the polarity of the current corresponds to the direction of the vibrating body — that is, to the condensations and rarefactions of air produced by the vibration. Hence, the sinusoidal curve A or B, Fig. 4, represents, graphically, the electrical undulations induced in a circuit by the vibration of a body capable of inductive action.

The horizontal line *a d e f*, &c., represents the zero of current. The elevations *b b b*, &c., indicate impulses of positive electricity. The depressions *c c c*, &c., show impulses of negative electricity. The vertical distance *b d* or *c f* of any portion of the curve from the zero-line expresses the intensity of the positive or negative impulse at the part observed, and the horizontal distance *a a* indicates the duration of the electrical oscillation. The vibrations represented by the sinusoidal curves B and A, Fig. 4, are in the ratio aforesaid, of 4 to 5 — that is, four oscillations of B are made in the same time as five oscillations of A.

The combined effect of A and B, when induced simultaneously on the same circuit, is expressed by the curve A + B, Fig. 4, which is the algebraical sum of the sinusoidal curves A and B. This curve A+B also indicates the actual motion of the air when the two musical notes considered are sounded simultaneously. Thus, when electrical undulations of different rates are simultaneously induced in the same circuit, an effect is produced exactly analogous to that occasioned in the air by the vibration of the inducing bodies. Hence, the co-existence upon a telegraphic circuit of electrical vibrations of different pitch is manifested, not by the obliteration of the vibratory character of the current, but by peculiarities in the shapes of the electrical undulations, or, in other words, by peculiarities in the shapes of the curves which represent those undulations.

There are many ways of producing undulatory currents of electricity, dependent for effect upon the vibrations or motions of bodies capable of inductive action. A few of the methods that may be

employed I shall here specify. When a wire, through which a continuous current of electricity is passing, is caused to vibrate in the neighborhood of another wire, an undulatory current of electricity is induced in the latter. When a cylinder, upon which are arranged bar-magnets, is made to rotate in front of the pole of an electro-magnet, an undulatory current of electricity is induced in the coils of the electro-magnet.

Undulations are caused in a continuous voltaic current by the vibration or motion of bodies capable of inductive action; or by the vibration of the conducting-wire itself in the neighborhood of such bodies. Electrical undulations may also be caused by alternately increasing and diminishing the resistance of the circuit, or by alternately increasing and diminishing the power of the battery. The internal resistance of a battery is diminished by bringing the voltaic elements nearer together, and increased by placing them farther apart. The reciprocal vibration of the elements of a battery, therefore, occasions an undulatory action in the voltaic current. The external resistance may also be varied. For instance, let mercury or some other liquid form part of a voltaic circuit, then the more deeply the conducting-wire is immersed in the mercury or other liquid, the less resistance does the liquid offer to the passage of the current. Hence, the vibration of the conducting-wire in mercury or other liquid included in the circuit occasions undulations in the current. The vertical vibrations of the elements of a battery in the liquid in which they are immersed produces an undulatory action in the current by alternately increasing and diminishing the power of the battery.

In illustration of the method of creating electrical undulations, I shall show and describe one form of apparatus for producing the effect. I prefer to employ for this purpose an electro-magnet, A, Fig. 5, having a coil upon only one of its legs *b*. A steel-spring armature, *c*, is firmly clamped by one extremity to the uncovered leg *d* of the magnet, and its free end is allowed to project above the pole of the covered leg. The armature *c* can be set in vibration in a variety of ways, one of which is by wind, and, in vibrating, it produces a musical note of a certain definite pitch.

When the instrument A is placed in a voltaic circuit, *g b e f g*,

the armature *c* becomes magnetic, and the polarity of its free end is opposed to that of the magnet underneath. So long as the armature *c* remains at rest, no effect is produced upon the voltaic current, but the moment it is set in vibration to produce its musical note a powerful inductive action takes place, and electrical undulations traverse the circuit *g b e f g*. The vibratory current passing through the coil of the electro-magnet *f* causes vibration in its armature *h* when the armature *c h* of the two instruments A I are normally in unison with one another; but the armature *h* is unaffected by the passage of the undulatory current when the pitches of the two instruments are different.

A number of instruments may be placed upon a telegraphic circuit, as in Fig. 6. When the armature of any one of the instruments is set in vibration all the other instruments upon the circuit which are in unison with it respond, but those which have normally a different rate of vibration remain silent. Thus, if A, Fig. 6, is set in vibration, the armatures of A^1 and A^2 will vibrate also, but all the others on the circuit will remain still. So if B^1 is caused to emit its musical note the instruments B B^2 respond. They continue sounding so long as the mechanical vibration of B^1 is continued, but become silent with the cessation of its motion. The duration of the sound may be used to indicate the dot or dash of the Morse alphabet, and thus a telegraphic dispatch may be indicated by alternately interrupting and renewing the sound. When two or more instruments of different pitch are simultaneously caused to vibrate, all the instruments of corresponding pitches upon the circuit are set in vibration, each responding to that one only of the transmitting instruments with which it is in unison. Thus the signals of A, Fig. 6, are repeated by A^1 and A^2, but by no other instrument upon the circuit; the signals of B^2 by B and B^1; and the signals of C^1 by C and C^2 — whether A, B^2, and C^1 are successively or simultaneously caused to vibrate. Hence by these instruments two or more telegraphic signals or messages may be sent simultaneously over the same circuit without interfering with one another.

I desire here to remark that there are many other uses to which these instruments may be put, such as the simultaneous transmission

of musical notes, differing in loudness as well as in pitch, and the telegraphic transmission of noises or sounds of any kind.

When the armature *c*, Fig. 5, is set in vibration the armature *h* responds not only in pitch but in loudness. Thus, when *c* vibrates with little amplitude, a very soft musical note proceeds from *h*; and when *c* vibrates forcibly the amplitude of the vibration of *h* is considerably increased, and the resulting sound becomes louder. So, if A and B, Fig. 6, are sounded simultaneously, (A loudly and B softly,) the instruments A^1 and A^2 repeat loudly the signals of A, and B^1 B^2 repeat softly those of B.

One of the ways in which the armature *c*, Fig. 5, may be set in vibration has been stated above to be by wind. Another mode is shown in Fig. 7, whereby motion can be imparted to the armature by the human voice or by means of a musical instrument.

The armature *c*, Fig. 7, is fastened loosely by one extremity to the uncovered leg *d* of the electro-magnet *b*, and its other extremity is attached to the centre of a stretched membrane, *a*. A cone, A, is used to converge sound-vibrations upon the membrane. When a sound is uttered in the cone the membrane *a* is set in vibration, the armature *c* is forced to partake of the motion, and thus electrical undulations are created upon the circuit E *b e f g*. These undulations are similar in form to the air vibrations caused by the sound — that is, they are represented graphically by similar curves. The undulatory current passing through the electro-magnet *f* influences its armature *h* to copy the motion of the armature *c*. A similar sound to that uttered into A is then heard to proceed from L.

In this specification the three words "oscillation," "vibration," and "undulation," are used synonymously, and in contradistinction to the terms "intermittent" and "pulsatory." By the term "body capable of inductive action," I mean a body which, when in motion, produces dynamical electricity. I include in the category of bodies capable of inductive action — brass, copper, and other metals, as well as iron and steel.

Having described my invention, what I claim, and desire to secure by Letters Patent, is as follows:

1. A system of telegraphy in which the receiver is set in vibra-

tion by the employment of undulatory currents of electricity, substantially as set forth.

2. The combination, substantially as set forth, of a permanent magnet or other body capable of inductive action, with a closed circuit, so that the vibration of the one shall occasion electrical undulations in the other, or in itself, and this I claim, whether the permanent magnet be set in vibration in the neighborhood of the conducting-wire forming the circuit, or whether the conducting-wire be set in vibration in the neighborhood of the permanent magnet, or whether the conducting-wire and the permanent magnet both simultaneously be set in vibration in each other's neighborhood.

3. The method of producing undulations in a continuous voltaic current by the vibration or motion of bodies capable of inductive action, or by the vibration or motion of the conducting-wire itself, in the neighborhood of such bodies, as set forth.

4. The method of producing undulations in a continuous voltaic circuit by gradually increasing and diminishing the resistance of the circuit, or by gradually increasing and diminishing the power of the battery, as set forth.

5. The method of, and apparatus for, transmitting vocal or other sounds telegraphically, as herein described, by causing electrical undulations, similar in form to the vibrations of the air accompanying the said vocal or other sounds, substantially as set forth.

In testimony whereof I have hereunto signed my name this 20th day of January, A. D. 1876.

ALEX. GRAHAM BELL.

Witnesses:

THOMAS E. BARRY,

P. D. RICHARDS.

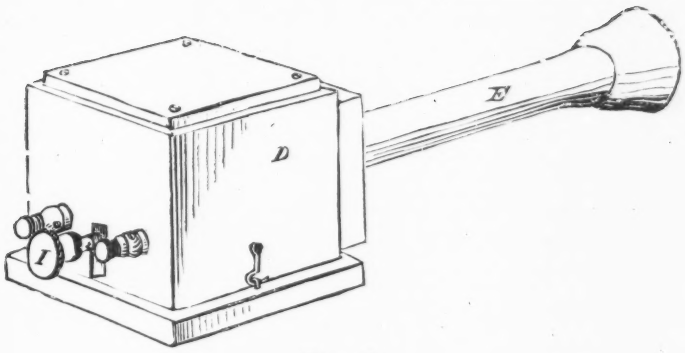


Fig. 2.

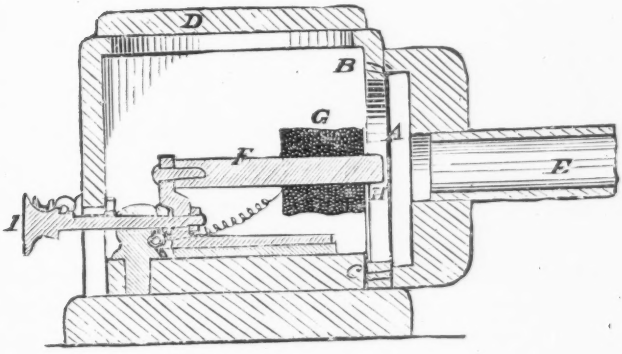
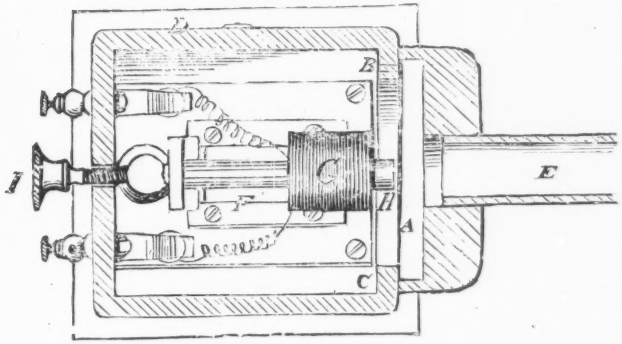


Fig. 3.



Attest:

P. Pollock

A. Ewell Castick

Inventor

Alexander Graham Bell

Fig. 4.

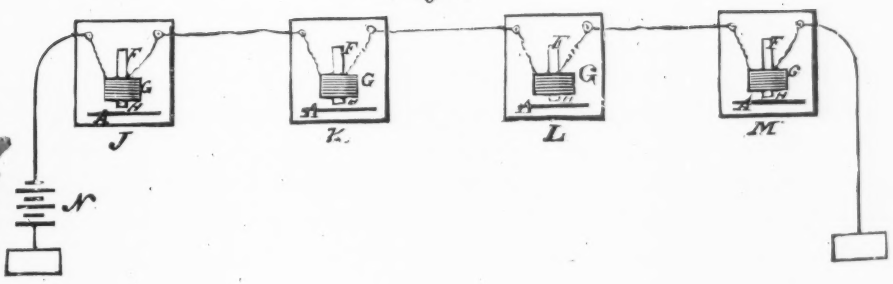


Fig 5.

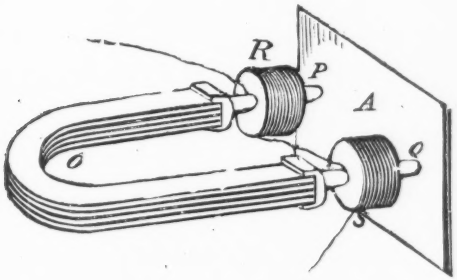
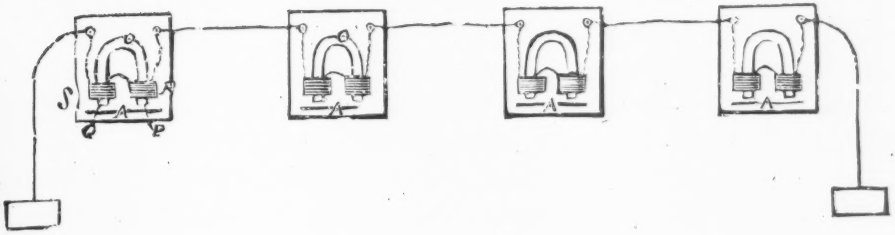


Fig. 6.



Attest:

A. Pollok
Everardick

Inventor:

Alexander Graham Bell

UNITED STATES PATENT OFFICE.

ALEXANDER GRAHAM BELL, OF BOSTON, MASSACHUSETTS.

IMPROVEMENT IN ELECTRIC TELEGRAPHY.

Specification forming part of Letters Patent No. 186,787, dated January 30, 1877; application filed January 15, 1877.

To all whom it may concern:

Be it known that I, ALEXANDER GRAHAM BELL, of Boston, Massachusetts, have invented certain new and useful Improvements in Electric Telephony, of which the following is a specification:

In Letters Patent granted to me the 6th day of April, 1875, No. 161,739, and in an application for Letters Patent of the United States now pending, I have described a method of and apparatus for producing musical tones by the action of a rapidly-interrupted electrical current, whereby a number of telegraphic signals can be sent simultaneously along a single circuit.

In another application for Letters Patent now pending in the United States Patent Office I have described a method of and apparatus for inducing an intermittent current of electricity upon a line-wire, whereby musical tones can be produced and a number of telegraphic signals be sent simultaneously over the same circuit, in either or in both directions; and in Letters Patent granted to me March 7, 1876, No. 174,465, I have shown and described a method of an apparatus for producing musical tones by the action of undulatory currents of electricity, whereby a number of telegraphic signals can be sent simultaneously over the same circuit, in either or in both directions, and a single battery be used for the whole circuit.

In the applications and patents above referred to, signals are transmitted simultaneously along a single wire by the employment of transmitting-instruments, each of which occasions a succession of electrical impulses differing in rate from the others, and are received without confusion by means of receiving-instruments, each tuned to

a pitch at which it will be put in vibration to produce its fundamental note by one only of the transmitting-instruments. A separate instrument is therefore employed for every pitch, each instrument being capable of transmitting or receiving but a single note, and thus as many separate instruments are required as there are messages or musical notes to be transmitted.

My invention has for its object, first, the transmission simultaneously of two or more musical notes or telegraphic signals along a single wire in either or both directions, and with a single battery for the whole circuit without the use of as many instruments as there are musical notes or telegraphic signals to be transmitted; second, the electrical transmission by the same means of articulate speech and sound of every kind, whether musical or not; third, the electrical transmission of musical tones, articulate speech, or sounds of every kind, without the necessity of using a voltaic battery.

In my Patent No. 174,465, dated March 7, 1876, I have shown as one form of transmitting-instrument a stretched membrane, to which the armature of an electro-magnet is attached, whereby motion can be imparted to the armature by the human voice, or by means of a musical instrument, or by sounds produced in any way.

In accordance with my present invention I substitute for the membrane and armature shown in the transmitting and receiving instruments alluded to above a plate of iron or steel capable of being thrown into vibration by sounds made in its neighborhood.

The nature of my invention and the manner in which the same is or may be carried into effect will be understood by reference to the accompanying drawings, in which —

Figure 1 is a perspective view of one form of my electric telephone. Fig. 2 is a vertical section of the same, and Fig. 3 is a plan view of the apparatus. Fig. 4 is a diagram illustrating the arrangement upon circuit.

Similar letters in the drawings represent corresponding portions of the apparatus.

A in said drawings represents a plate of iron or steel, which is fastened at B and C to the cover or sounding-box D. E represents a speaking-tube, by which sounds may be conveyed to or from the

plate A. F is a bar of soft iron. G is a coil of insulated copper wire, placed around the extremity of the end H of the bar F. I is an adjusting-screw, whereby the distance of the end H from the plate A may be regulated.

The electric telephones J, K, L, and M are placed at different stations upon a line, and are arranged upon circuit with a battery, N, as shown in diagram, Fig. 4.

I have shown the apparatus in one of its simplest forms, it being well understood that the same may be varied in arrangement, combination, general construction, and form, as well as material of which the several parts are composed.

The operation and use of this instrument are as follows:

I would premise by saying that this instrument is and may be used both as a transmitter and as a receiver — that is to say, the sender of the message will use an instrument in every particular identical in construction and operation with that employed by the receiver, so that the same instrument can be used alternately as a receiver and a transmitter.

In order to transmit a telegraphic message by means of these instruments, it is only necessary for the operator at a telephone (say J) to make a musical sound in any way in the neighborhood of the plate A — for convenience of operation, through the speaking-tube E — and to let the duration of the sound signify the dot or dash of the Morse alphabet, and for the operator who receives his message (say at M) to listen to his telephone, preferably through the speaking-tube E. When two or more musical signals are being transmitted over the same circuit all the telephones reproduce the signals for all the messages; but as the signals for each message differ in pitch from those for the other messages, it is easy for an operator to fix his attention upon one message and ignore the other.

When a large number of despatches are being simultaneously transmitted it will be advisable for the operator to listen to his telephone through a resonator, which will re-enforce to his ear the signals which he desires to observe. In this way he is enabled to direct his attention to the signals for any given message without

being distracted or disturbed by the signals for any other messages that may be passing over the line at the time.

The musical signals, if preferred, can be automatically received by means of a resonator, one end of which is closed by a membrane, which vibrates only when the note with which the resonator is in unison is emitted by the receiving-telephone. The vibrations of the membrane may be made to operate a circuit-breaker, which will actuate a Morse sounder or a telegraphic recording or registering apparatus.

One form of vibratory circuit-breaker which may be used for this purpose I have described in Letters Patent No. 178,399, June 6, 1876. Hence by this plan the simultaneous transmission of a number of telegraphic messages over a single circuit in the same or in both directions with a single main battery for the whole circuit and a single telephone at each station is rendered practicable. This is of great advantage in this, that for the conveyance of several messages, or signals, or sounds over a single wire simultaneously, it is no longer necessary to have separate instruments correspondingly tuned for each given sound, which plan requires nice adjustment of the corresponding instruments, while the present improvement admits of a single instrument at each station, or, if for convenience several are employed, they all are alike in construction, and need not be adjusted or tuned to particular pitches.

Whatever sound is made in the neighborhood of any telephone — say at J, Fig. 4 — is echoed in fac-simile by the telephones of all the other stations upon the circuit; hence this plan is also adapted for the use of the transmitting intelligibly the exact sounds of articulate speech. To convey an articulate message it is only necessary for an operator to speak in the neighborhood of his telephone, preferably through the tube E, and for another operator at a distant station upon the same circuit to listen to the telephone at that station. If two persons speak simultaneously in the neighborhood of the same or different telephones, the utterances of the two speakers are reproduced simultaneously by all the other telephones on the same circuit; hence by this plan a number of vocal messages may be transmitted simultaneously on the same circuit, in either or both directions. All the effects noted above may be produced by the

same instruments without a battery by rendering the central bar F H permanently magnetic. Another form of telephone for use without a battery is shown in Fig. 5, in which O is a compound permanent magnet, to the poles of which are affixed poll-pieces of soft iron, P Q, surrounded by helices of insulated wire R S.

Fig. 6 illustrates the arrangement upon circuits of similar instruments to that shown in Fig. 5.

In lieu of the plate A in above figures, iron or steel reeds of definite pitch may be placed in front of the electro-magnet O, and, in connection with a series of such instruments of different pitches, an arrangement upon circuit may be employed similar to that shown in my Patent No. 174,465, and illustrated in Fig. 6 of Sheet 2 in said patent. The battery, of course, may be omitted.

This invention is not limited to the use of iron or steel, but includes within its scope any material capable of inductive action.

The essential feature of the invention consists in the armature of the receiving-instrument being vibrated by the varying attraction of the electro-magnet so as to vibrate the air in the vicinity thereof in the same manner as the air is vibrated at the other end by the production of the sound. It is, therefore, by no means necessary or essential that the transmitting-instrument should be of the same construction as the receiving-instrument. Any instrument receiving and transmitting the impression of agitated air may be used as the transmitter, although, for convenience and for reciprocal communication, I prefer to use like instruments at either end of an electrical wire. I have heretofore described and exhibited such other means of transmitting sound, as will be seen by reference to the proceedings of the American Academy of Arts and Sciences, Volume XII.

For convenience, I prefer to apply to each instrument a call-bell. This may be arranged so as to ring, first, when the main circuit is opened; second, when the bar F comes into contact with the plate A. The first is done to call attention; the second indicates when it is necessary to readjust the magnet, for it is important that the distance of the magnet from the plate should be as little as possible, without, however, being in contact. I have also found that the electrical undulations produced upon the main line by the vibration of the plate A are intensified by placing the coil G at the end of the

bar F nearest the plate A, and not extend it beyond the middle, or thereabout.

Having thus described my invention, what I claim, and desire to secure by Letters Patent, is—

1. The union upon, and by means of, an electric circuit of two or more instruments, constructed for operation substantially as herein shown and described, so that, if motion of any kind or form be produced in any way in the armature of any one of the said instruments, the armatures of all the other instruments upon the same circuit will be moved in like manner and form, and if such motion be produced in the former by sound, like sound will be produced by the motion of the latter.

2. In a system of electric telegraphy or telephony, consisting of transmitting and receiving instruments united upon an electric circuit, the production, in the armature of each receiving-instrument, of any given motion by subjecting said armature to an attraction varying in intensity, however such variation may be produced in the magnet; and hence I claim the production of any given sound or sounds from the armature of the receiving-instrument by subjecting said armature to an attraction varying in intensity, in such manner as to throw the armature into that form of vibration that characterizes the given sound or sounds.

3. The combination, with an electro-magnet, of a plate of iron or steel, or other material capable of inductive action, which can be thrown into vibration by the movement of surrounding air or by the attraction of a magnet.

4. In combination with a plate and electro magnet, as before claimed, the means herein described, or their mechanical equivalents, of adjusting the relative position of the two so that, without touching, they may be set as closely together as possible.

5. The formation, in an electric telephone such as herein shown and described, of a magnet with a coil upon the end or ends of the magnet nearest the plate.

6. The combination, with an electric telephone such as described, of a sounding-box, substantially as herein shown and set forth.

7. In combination with an electric telephone, as herein described,

the employment of a speaking or hearing tube for conveying sounds to or from the telephone, substantially as set forth.

8. In a system of electric telephony, the combination of a permanent magnet with a plate of iron or steel, or other material capable of inductive action, with coils upon the end or ends of said magnet nearest the plate, substantially as set forth.

In testimony whereof I have hereunto signed my name this 13th day of January, A. D. 1877.

A. GRAHAM BELL.

Witnesses:

HENRY R. ELLIOTT,

EWELL A. DICK.

DEPOSITION OF CHARLES E. HUBBARD.

Direct Examination by GEORGE L. ROBERTS, Esq., *of Counsel for Complainants.*

BOSTON, Dec. 19, 1883.

Int. 1. State your name, age, residence, and occupation.

Ans. Charles Eustis Hubbard; I am forty-one years old; I live in Boston, and am a lawyer.

Int. 2. I show you a certified copy of certain assignments marked "Exhibit Assignments," and call your attention to the first instrument contained therein, dated July, 1877, which shows the name of Charles Eustis Hubbard as an attesting witness. Please state whether you remember to have witnessed the execution of the original assignment, and to have signed the same as the attesting witness thereof.

Ans. I do. I drafted the assignment and witnessed the signature of Alexander Graham Bell to said assignment. It was signed in my office by him in my presence.

Int. 3. The grantee of this instrument is Gardiner G. Hubbard, trustee: was there, to your knowledge, a written instrument defining the powers and duties of such trustee; and what relation is the said Gardiner G. Hubbard to you?

Ans. There was an instrument in writing defining the trust. It was drafted by me and was executed by the said Gardiner G. Hubbard at my office and in my presence, and I signed it as an attesting witness. Said Gardiner G. Hubbard is my brother.

Int. 4. Please examine the certified copy now shown you, and state whether it is a copy of the declaration of trust just referred to by you.

Ans. It is.

[*Counsel for complainants puts the said certified copy in evidence, and the same is marked "Exhibit Hubbard's Declaration of Trust."*]

Int. 5. This declaration of trust provides for management on behalf of the beneficiaries by a board of managers and by action of the beneficiaries as an association: did you hold any official position in this association, and if so what?

Ans. I did; I was the clerk of the association, and one of the board of managers.

Int. 6. Did you ever have in your possession as clerk of the said association the original assignment of July, 1877, from Alexander Graham Bell to Gardiner G. Hubbard, trustee, a certified copy of which you have identified, and the original declaration of trust signed by Gardiner G. Hubbard, a certified copy of which you have also identified? And if you ever had such original papers in your possession, state whether you know where they now are, and with what diligence you have made search for them.

Ans. I was the counsel for the parties interested in the Bell patents at that time, July, 1877. After the assignment and declaration of trust were executed, as before stated by me, I forwarded them to the Patent Office for record. This was prior to the organization of the association. I am advised that the originals were returned to me from the Patent Office, and I have no doubt that I had the custody of them as clerk of the association; but, though I have made diligent search through all my papers in three safes, and also at the house of Gardiner G. Hubbard, I have been unable to find the original papers.

Int. 7. I show you a paper which purports to be an assignment from Gardiner G. Hubbard, trustee, to the Bell Telephone Company, dated July 20, 1878, and recorded in the Patent Office, Oct. 3, 1878, Liber Y^{22}, page 460, of Transfers of Patents. Please state whether your signature is upon this instrument as one of the attesting witnesses, and what you know as to its execution, and the genuineness of the signature of Gardiner G. Hubbard, trustee, which appears thereon.

Ans. My signature is upon that instrument. The assignment was drafted by me, is in my own handwriting, and was executed by Gardiner G. Hubbard as trustee in my presence.

Int. 8. By the tenth provision of the declaration of trust it is provided that

"The property held in trust, or any portion thereof, shall be sold, transferred, conveyed, released and delivered by the Trustee free of and discharged from this trust or otherwise whenever he is directed by a vote of the shareholders so to do at a meeting called and held for that purpose, and at which at least seven eighths in interest of the shares are represented."

Will you please refer to the book of records kept by you as clerk of the association for whose benefit this trust was held, and state what authorization if any was made for the assignment which you have just identified, dated July 20, 1878.

Ans. At the annual meeting of the shareholders, which was held on the 19th of July, 1878, by adjournment from the 18th of July, and at which the shareholders representing 4,490 out of 5,000 shares were present in person or by proxy, a vote was passed unanimously, as follows: —

"*Voted*, That the trustee be and he hereby is authorized, instructed and empowered to sell, assign and transfer, by proper and sufficient conveyance, to said Bell Telephone Company, all the patents, patent rights, and interest in any and all contracts relating to any patents or future inventions owned or held by him as trustee; said company assuming all such contracts, and the burdens and obligations of said trustee thereunder, paying for such assignment three thousand shares of its capital stock fully paid up."

These records from which I quote are in my handwriting, and were kept by me as clerk of such association.

The call for this annual meeting was sent by me by a copy thereof to each of the shareholders of the association at least ten days before the time fixed for the meeting, and was as follows:

"BOSTON, July 8, 1878.

"*To*.....

Shareholder of the BELL TELEPHONE COMPANY:

You are hereby notified that the annual meeting of the Bell Telephone Company will be held at No. 13 Sears Building, Boston, on the eighteenth day of July, 1878 (Thursday) at 12 M., to consider, in addition to the regular business of the meeting, whether the association will ratify the contract of the trustee with the telephone company of New York, and whether the association will authorize the trustee to sell and dispose of all the property held in trust for the association, and upon what terms and conditions.

Per order of the Trustee,

C. E. HUBBARD

Clerk of the Bell Telephone Company."

Int. 9. I now show you a written instrument purporting to be an assignment from the Bell Telephone Company to the American Bell Telephone Company, dated June 22, 1880, and recorded in the Patent Office, June 24, 1880, Liber I[25], page 282, of Transfers of

Patents. Please state whether you know the signatures which appear thereon, and how you have derived your knowledge of the handwriting.

Ans. I do know the signatures thereon, and am familiar with the handwriting of both the signers thereto, having frequently seen them write, and having constant occasion to see their signatures from my position as clerk of the American Bell Telephone Company and of the Bell Telephone Company, of which they are respectively the president and treasurer.

Int. 10. Will you refer to the records of the Bell Telephone Company kept by you, and state when in the year 1880 the said W. H. Forbes was re-elected president and the said Wm. R. Driver treasurer?

Ans. On the twenty-first day of June, 1880, at a special meeting of the stockholders of the Bell Telephone Company, duly called, at which a quorum was present, Wm. R. Driver was duly elected treasurer of the company, and Wm. H. Forbes was duly elected a director of said Bell Telephone Company. At a meeting of the directors of the Bell Telephone Company duly called, and held June 22, 1880, Wm. H. Forbes was duly elected president of the Bell Telephone Company. I was clerk of the company, and I obtain this information from the records of the company, which were kept by me, and which are in my handwriting.

Int. 11. What authorization by the Bell Telephone Company was there for the execution of this assignment on its behalf by its president and treasurer to the American Bell Telephone Company?

Ans. A vote was passed at a meeting of the stockholders of the Bell Telephone Company duly called and held at the company's office, June 21, 1880, at which meeting a quorum was present, authorizing the president and treasurer to make the assignment and transfer referred to in the interrogatory. A copy of the vote giving such authority, duly certified by me as clerk of the Bell Telephone company, is annexed to said instrument of transfer.

[*Counsel for complainants offers in evidence the two assignments identified by the witness, to wit, that from Gardiner G. Hubbard, trustee, to the Bell Telephone Company, dated July* 20, 1878, *and that from the Bell Telephone Company to the American Bell Telephone Company, dated June* 22, 1880.

Counsel for defendants objects to the foregoing assignments being offered in evidence until he has had an opportunity to cross examine the witness, whose examination in chief has been taken for the purpose of laying a foundation in order to make these papers testimony.]

Cross Examination by S. S. HOLLINGSWORTH, Esq., *of Counsel for Defendants.*

Cross-Int. 12. Did all the shareholders of the association live in Boston?

Ans. They lived in Boston or the immediate vicinity. There were only seven shareholders: Alexander Graham Bell, Mabel G. Bell (his wife), Gardiner G. Hubbard, Gertrude McC. Hubbard (his daughter), Thomas Sanders, Thomas A. Watson and myself.

Cross-Int. 13. At what time were the notices dated July 8, 1878, mailed, and by whom?

Ans. I cannot state positively. They were mailed either by me or my office man, and, to the best of my recollection, before 3 o'clock, but I cannot state positively.

Cross-Int. 14. What makes you think they were mailed before 3 o'clock?

Ans. Because it was midsummer, and I was in the habit of leaving my office before that hour at that season.

Cross-Int. 15. Did your man leave at that hour?

Ans. He did not.

Cross-Int. 16. At what hour did he leave?

Ans. I don't know.

Cross-Int. 17. They may have been mailed by the man after 3, may they not?

Ans. They may have, but, from my usual habit in sending notices of this character, I have no doubt that they were mailed in time to fulfil the requirements of the provisions of the trust.

Cross-Int. 18. Would a letter mailed at or about 3 o'clock be delivered at Haverhill the same evening?

Ans. I am not sure. I presume so.

Cross-Int. 19. Do you know whether it would be delivered the evening or not?

Ans. I have no positive knowledge about it.

Cross-Int. 20. You have testified that the authorization of the execution of the assignment from the Bell Telephone Company to the American Bell Telephone Company was made at a meeting duly held and at which a quorum was present of the stockholders on June 21, 1880: was the Bell Telephone Company a corporation?

Ans. Yes.

Cross-Int. 21. Organized under the laws of Massachusetts?

Ans. Yes.

Cross-Int. 22. At what date was its annual meeting held?

Ans. The second Wednesday of September in each year.

Cross-Int. 23. Was the meeting of the 21st of June a special meeting?

Ans. It was a special meeting in lieu of the annual meeting, and so specified in the call.

Cross-Int. 24. What were the terms of the call for the meeting of June 21, 1878, and what was the provision of the charter or by-laws under which it was made?

Ans. So far as the call relates to the assignment of the patents, it was as follows: —

"2d. To appoint some one in the absence of the president to assign and transfer the patents No. 174,465, dated March 7, 1876, and No. 186,787, dated Jan. 30, 1877, or any territorial or other interest in them, to such assignee as the National Bell Telephone Company may request, in accordance with the agreement with said National Bell Telephone Company, dated March 20, 1879, and in pursuance of the vote passed at the stockholders' meeting, held Feb. 20, 1879, authorizing the president and treasurer to convey all the property of this company to the National Bell Telephone Company.

Article 2 of the by-laws is as follows: —

"The officers of the corporation shall consist of a clerk, treasurer and eight directors, to be chosen by the stockholders by ballot at their annual meeting or at any meeting held in lieu of the annual meeting for that purpose, and a president shall be chosen by the directors from their number by ballot."

Article 4. is: —

"A special meeting of the stockholders may be called by the directors at any time, and the clerk shall call a special meeting whenever he is requested so to do in writing by two of the directors or by stockholders representing one fourth of the shares in the company."

Direct Examination resumed.

Int. 25. Will you again refer to the records of the association of which Gardiner G. Hubbard was trustee and read therefrom what you recorded preceding the copy of the notice sent to the shareholders for the meeting to be held July 18, 1878?

Ans. "Shareholders' meeting.

"In accordance with the following notice sent to each of the shareholders at least ten days before the time fixed for the meeting."

Int. 26. What follows immediately after a copy of the notice which you have already quoted in answer to Int. 8?

Ans. "The annual meeting of the Association was held at No. 13 Sears Building, Boston, on Thursday, July 18, 1878, at 12 M."

Int. 27. That notice is addressed to "Shareholder of the Bell Telephone Company": will you explain the distinction between this name and the same name as applied to the corporation established under the laws of Massachusetts?

Ans. The association was known to the public as the Bell Telephone Company, and the corporation, which was organized under the laws of Massachusetts, and succeeded to the business of the association, was incorporated as the Bell Telephone Company, the same name being preserved.

CHAS. EUSTIS HUBBARD.

Attest: CHAS. H. SWAN, *Special Examiner.*

[*The examination of the witness having been concluded, counsel for defendant now objects to the offer of the assignment from Gardiner G. Hubbard, trustee, to the Bell Telephone Company, for the following reason: The effect of the declaration of trust of Gardiner G. Hubbard was to put into him the legal title to the patents already therein referred to, to be conveyed, if conveyed in accordance with the terms of a collateral power in the association, to be exercised in accordance with the terms of said declaration of trust, and that it does not affirmatively appear from the evidence of the witness that in the execution of such power the terms of the declaration of trust, so far as the calling of the special meeting was concerned, were strictly complied with, and that consequently said conveyance is inoperative and void.*

It is agreed that the certified copies from the Patent Office may be

put in evidence with the same force and effect as the original assignments, Hubbard, trustee, to Bell Telephone Company, and Bell Telephone Company to American Bell Telephone Company, which have been here produced, and subject to the same objections.]

COMPLAINANTS' EXHIBIT HUBBARD'S DECLARATION OF TRUST.

BELL TELEPHONE COMPANY DECLARATION OF TRUST.

Liber R[21], p. 400.

Whereas, Letters Patent of the United States were issued to Alexander Graham Bell as assignor of himself, Thomas Sanders and Gardiner G. Hubbard, bearing date April 6, 1875, and numbered 161,739; to Alexander Graham Bell, bearing date March 7, 1876, and numbered 174,465; to Alexander Graham Bell, bearing date June 6, 1876, and numbered 178,399; and to Alexander Graham Bell, bearing date Jan. 30, 1877, and numbered 186,787.

All of said Letters Patent being for improvements in "Telegraphy, Telephony and Telephonic Apparatus" invented by said Alexander Graham Bell;

And whereas said inventions and said Letters Patent have all been assigned to Gardiner G. Hubbard of Cambridge, in the County of Middlesex and Commonwealth of Massachusetts, Trustee;

And whereas it is proposed to organize an Association for the purpose of manufacturing and introducing said Telephones into general use throughout the United States:

Now, therefore, I, the said Gardiner G. Hubbard, agree to and by these Presents, do place said Patents and all other Patents and Inventions relating to Telephones which I may hereafter receive or acquire; also all the profits and proceeds derived from licensing or authorizing others to make, use, sell and introduce into use, said Telephones, and from the sale of all or any portion or portions or the territorial right to make, use or sell the said Telephones, under said Patents or any of them, after deducting therefrom and paying all the costs, charges and expenses of or incident to said business, in trust. And I will, and my successors in trust shall hold the same and all the same in trust, until disposed of as hereinafter provided; and I

do hereby declare said trust and the terms, conditions, provisions, restrictions and limitations thereof, which shall be and continue equally binding upon me and my successors in trust, and all the persons and parties who now are or may hereafter become owners of or interested in the shares herein and hereby created, to wit: —

First. The business of manufacturing Telephones and licensing parties to use the same for a royalty shall be carried on and managed by the trustee under the name of the Bell Telephone Company under and in accordance with such general directions, rules and regulations as may be made for that purpose by the Board of Managers hereinafter provided for, and all the results and profits thereof, after paying all the proper costs and expenses of carrying on and managing said business, and all the property and money which may be paid to or come into the hands of the said Trustee, belonging to this business, and the proceeds of the sale of said property, if the same shall ever be sold, under the provisions hereinafter contained, shall all be held in trust until the same is paid over to the Association herein and hereby organized; and the rights to the same, when divided, as hereinafter provided for, shall be and hereby are divided into five thousand shares.

Second. The owners of said shares shall constitute and become, by the fact of such ownership, an Association of which each individual owner of one or more shares shall be an individual member during such ownership, and in all meetings of such Association herein provided for each and every member of said Association shall be entitled to one vote in person or by proxy for each and every share owned by him and standing in his name, and each share shall entitle its owner to its *pro rata* share in all moneys divided by the Board of Managers upon said shares.

Third. No member of said Association shall as such or in consequence of such membership have any right to or control over any property or money in the hands of the Trustee or Treasurer, or of the business herein contemplated, except by and through the Board of Managers herein provided for; and no member of the Association or of the Board of Managers shall have authority or right to bind or render liable the Association, or the individual members thereof, by any contract or obligation whatever.

Fourth. All the business affairs and interests of said Association shall be wholly under the supervision and control of a Board of Managers of not less than three nor more than five persons, of whom the Trustee shall be one, the others to be elected by the members of the Association from their number by ballot; said Board of Managers shall act only as a Board, a majority of them constituting a quorum for business. All the active business of the Association shall be done by agents, clerks and servants, who shall be appointed by and responsible to said Board; and no member of the Association, whether a Manager or not, shall have any authority to act for the association in any way whatever, except as he may be authorized by the Board of Managers. The Board of Managers may refer any question of business of the Association to a meeting of the shareholders, and in such case shall act in accordance with such vote or votes as may be passed in relation thereto; and they shall in all cases when a vote is passed by the shareholders upon any question of interest to the Association be governed by such vote. The Board of Managers shall declare and cause to be paid to the shareholders *pro rata* dividends of net money in the hands of the Treasurer. Meetings of the Board of Managers shall be called in such way as they may prescribe.

Fifth. The Board of Managers and all other officers of the Association shall hold their offices and perform the duties thereof until others are elected or appointed in their places. When a vacancy occurs in the Board of Managers, it shall be filled by an election by the remaining members of the Board, until the next regular meeting, when the shareholders may elect.

Sixth. A regular annual meeting of the shareholders of the Association shall be held on the first Monday of June in each year, at twelve o'clock, noon, at such place as shall be appointed by the Board of Managers, of which notice shall be addressed by mail to each shareholder at his last known post-office address. At such annual meeting, or any special meeting called in lieu of it, a Board of Managers, Treasurer and Clerk shall be elected, and any other business which may properly come before the Association voted upon. At all meetings of the shareholders, one half in interest in the Association, if no more be present, shall constitute a quorum. The

ustee shall preside at all meetings, if present; if not present, a presiding officer shall be chosen. If by mistake or otherwise the annual meeting is not held at the time and in the manner specified, it may be called and held at any time and place designated by the Board of Managers or the Trustee, by sending notice to each shareholder by mail, as above specified, at least ten days before the time designated for the meeting; and the sworn certificate of the Trustee or either one of the Board of Managers, that such notice was given shall be deemed conclusive evidence that it was so given. A special meeting of the shareholders shall be called by the Trustee or or any member of the Board of Managers to vote in relation to any question of interest to the Association, when one third in interest of the shareholders shall make a request in writing to that effect, notice of the meeting and the purpose of it to be given as before provided. A legal meeting of the shareholders may be held at any time when all the shares are represented by the owners in person or by proxy, without any previous notice. Records of all meetings of shareholders and of the Board of Managers shall be made by the Trustee or other person appointed for that purpose by the Board of Managers in books kept by the Association for the purpose, which shall clearly set forth all votes passed or acted upon, which shall be attested by the person making it; and such attestation shall be conclusive of its correctness.

Seventh. Each shareholder in the Association shall be entitled to and receive from the Trustee a certificate setting forth how many shares therein he is the owner of, which certificate shall bear upon the back of it this Declaration of Trust. Shares in this Association and all the rights and interests they represent may be transferred by an assignment in writing on the certificate; but no transfer of shares will be recognized by the Trustee until the old certificate is surrendered and a new one issued, according to the interest of the parties. There shall be kept by the Trustee a record of all the shares of the Association and all transfers of the same, and the residences of the owners as given by them.

Eighth. The Treasurer of the Association, or other officer appointed for that purpose, shall keep a clear and accurate account, by double entry, of all the business transactions of the Association,

which said books and all other books of the Association shall always, at reasonable business hours, be open for inspection by the shareowners. The Trustee shall keep a full and complete record of all the business done by him as Trustee under this Trust, which shall at all times be open to inspection by the Board of Managers.

Ninth. If no other provision is made by the Board of Managers, the Trustee shall act as general agent of the Association, and shall perform or cause to be performed under his supervision, and in accordance with the directions of the Board of Managers, the duties of such office until special officers are appointed by the Board of Managers to perform them; and the Trustee or other officer in charge of the business shall pay out of the funds of the Association, subject to the direction of the Board of Managers, all the proper and legitimate charges and expenses incurred by him in and about the management of the business.

Tenth. The property held in trust, or any portion thereof, shall be sold, transferred, conveyed, released and delivered by the Trustee free of and discharged from this trust, or otherwise, whenever he is directed by a vote of the shareholders so to do at a meeting called and held for that purpose, and at which at least seven eighths in interest of the shares are represented; and when such disposition of the trust property is made, and the proceeds thereof, after paying all debts, costs, charges and expenses, have been paid over to the Association, and divided *pro rata* upon all the shares, then this Association shall be dissolved and cease to exist, and, upon payment of such final dividend, all the certificates shall be surrendered and cancelled.

The decease of any member of the Association shall not work a dissolution of it, nor shall it entitle his legal representatives to an account, or to take any action in the Courts or otherwise against the Association or the Trustee for such account; but they shall simply succeed to the right of the deceased to the certificate and the shares it represents, subject to this Declaration of Trust.

Eleventh. In case of the decease, resignation or inability of the Trustee to act, a special meeting of shareholders shall be called for the purpose, and a new Trustee shall be elected, who shall succeed to all the rights and duties of his predecessor. If the shareholders

shall become dissatisfied with the Trustee for any reason whatever, and shall, at a meeting called for that purpose, by a vote of three quarters in interest, request his resignation, he shall cease to be and to act as Trustee, and upon the election of a new Trustee shall convey all the property, rights and interests held by him under this Trust to the new Trustee.

The shares and certificates representing them are issued by the Trustee and accepted by the holder, subject to all the foregoing provisions.

In witness whereof, I, the said Gardiner G. Hubbard, have hereunto set my hand and seal this ninth day of July, 1877.

GARDINER G. HUBBARD. [SEAL]

In presence of

CHAS. EUSTIS HUBBARD.

Recorded July 28, 1877.

EXHIBIT ASSIGNMENTS, C. H. S., EXAMINER.

BELL TO HUBBARD.

ASSIGNMENT OF PATENT RIGHT.

Liber R[21], p. 399.

To all whom it may concern: —

Whereas, Alexander Graham Bell, of Boston, in the county of Suffolk and State of Massachusetts, did obtain three several Letters Patent of the United States for an improved system of telegraphy, telephony and telephonic apparatus, which Letters Patent bear date respectively, March seventh, A. D. eighteen hundred and seventy-six, and numbered 174,465; June sixth, A. D. eighteen hundred and seventy-six, and numbered 178,399; and January thirtieth, A. D. eighteen hundred and seventy-seven, and numbered 186,787.

And whereas, Gardiner G. Hubbard of Cambridge, in the County of Middlesex and State of Massachusetts, Trustee, is desirous of acquiring an interest therein; Now this Indenture witnesseth that for a valuable consideration, viz., one dollar, and other valuable consideration to me in hand paid, the receipt of which is hereby acknowl-

edged, I have assigned, sold and set over, and by these presents do assign, sell and set over unto the said Gardiner G. Hubbard, Trustee, all the right, title and interest I have in the above-described invention, as secured to me by Letters Patent, for, to and in the United States and Territories, and in no other place or places. The same to be held and enjoyed by the said Gardiner G. Hubbard, Trustee, for his own use and behoof, and for the use and behoof of his legal representatives, to the full end of the term for which said Letters were granted, as fully and entirely as the same would have been held and enjoyed by me had this assignment and sale not been made.

In testimony whereof, I have hereunto set my hand and affixed my seal this day of July, in the year of our Lord one thousand eight hundred and seventy-seven.

ALEXANDER GRAHAM BELL. [SEAL]

Sealed and delivered in presence of
CHAS. EUSTIS HUBBARD.

Recorded July 28, 1877.

HUBBARD TO BELL TELEPHONE COMPANY

ASSIGNMENT OF PATENT RIGHT.

Liber Y^{22}, p. 460.

To all whom it may concern: —

Whereas, Alexander Graham Bell, of Salem, Massachusetts, as assignor to himself, Thomas Sanders and Gardiner G. Hubbard, did obtain Letters Patent of the United States, bearing date April 6, 1875, and numbered 161,739; and whereas said Alexander Graham Bell did obtain Letters Patent of the United States, bearing date March 7, 1876, and numbered 174,465; bearing date June 6, 1876, and numbered 178,399; and bearing date January, 30, 1877, and numbered 186,787, all of said Letters Patent, being for improvements in "Telegraphy, Telephony and Telephonic Apparatus," invented by said Alexander Graham Bell; and whereas all of said Letters Patent

have been assigned to Gardiner G. Hubbard, trustee, said Letters numbered 161,739, by deed of assignment, delivered July 9, 1877, and recorded in Liber T[21], page 448 of Transfers of Patents; and said Letters numbered 174,465, 178,399 and 186,787, by deed of assignment, delivered July 9, 1877, and recorded in Liber R[21], page 399 of Transfers of Patents; and said Hubbard, Trustee, is now the owner of the above-described inventions secured by said Letters Patent; and whereas the Bell Telephone Company, a corporation duly established under the laws of the Commonwealth of Massachusetts, and located at Boston, is desirous of acquiring the ownership of said inventions secured by said Letters Patent.

Now, this Indenture witnesseth that I, Gardiner G. Hubbard, Trustee, in consideration of one dollar, and other valuable consideration to me in hand paid by said Bell Telephone Company, the receipt whereof is hereby acknowledged, have assigned, sold and set over, and by these presents do assign, sell and set over unto the said Bell Telephone Company, all my right, title and interest in the above-described inventions and in and to said Letters Patent, each and all of them, the same to be held and enjoyed by the said Bell Telephone Company for its own use and behoof, and for the use and behoof of its legal representatives to the full end of the term for which said Letters were granted, and any extension or reissue thereof as fully and entirely as the same would have been held and enjoyed by me had this assignment and sale not been made.

In testimony whereof, I have hereunto set my hand and seal this twentieth day of July, in the year eighteen hundred and seventy-eight, being thereto duly authorized.

GARDINER G. HUBBARD, *Trustee.* [SEAL]

In presence of

C. E. HUBBARD.
R. W. DEVONSHIRE.

Recorded Oct. 3, 1878.

BELL TELEPHONE CO. TO AMERICAN BELL TELEPHONE CO.

Liber I[25], p. 282.

Know all men by these presents, That the Bell Telephone Company, a corporation established under the laws of the Commonwealth of Massachusetts, in consideration of one dollar to it paid by the American Bell Telephone Company, a corporation established under the laws of said Commonwealth, the receipt whereof is hereby acknowledged, does hereby grant and convey unto said American Bell Telephone Company the exclusive right under the following patents to all the territory of the United States except the State of Massachusetts, viz.: Letters Patent No. 174,465, issued March 7, 1876, to Alexander Graham Bell for an improvement in telegraphy, and Letters Patent No. 186,787, issued January 30, 1877, to said Alexander Graham Bell for an improvement in electric telegraphy, and in and to the inventions therein described or intended to be described.

To have and to hold the same to the said American Bell Telephone Company, its successors and assigns, to their own use and behoof forever.

This instrument is made at the request of the National Bell Telephone Company in pursuance of an agreement between said Bell Telephone Company and said National Bell Telephone Company, dated March 20, 1879, said American Bell Telephone Company being the appointees of said National Bell Telephone Company to receive this conveyance, and in pursuance of an agreement between said National Bell Telephone Company and said American Bell Telephone Company, dated May 8, 1880.

In witness whereof, said Bell Telephone Company has caused its corporate seal to be hereto affixed and these presents to be signed in its name and behalf by William H. Forbes, its president, and William R. Driver, its treasurer, thereto duly authorized, this twenty-second day of June, A. D. 1880.

[Seal of B. T. Co.] THE BELL TELEPHONE COMPANY,
By W. H. FORBES, *Pres't.*
WM. R. DRIVER, *Treasurer.*

Voted that the President and Treasurer be, and they hereby are authorized and empowered, in the name and on behalf of this Company, to assign and transfer the patents No. 174,465, dated March 7, 1876, and No. 186,787, dated Jan. 30, 1877, or any territorial or other interest in them, to such assignee as the National Bell Telephone Company may request, in accordance with the agreement with said National Bell Telephone Company, dated March 20, 1879, and in pursuance of the vote passed at the Stockholders' meeting, held Feb. 20, 1879, authorizing the President and Treasurer to convey all the property of this Company to the National Bell Telephone Company, such assignment and transfer to be made at such times and in such manner and for said such territory as said assignee may desire.

A true copy of vote passed at a stockholders' meeting of the Bell Telephone Company, duly held at Boston, Mass., June 21, 1880.

[SEAL] Attest: CHAS. EUSTIS HUBBARD,
Cerk of the Bell Telephone Co.

EXHIBIT COMPLAINANTS' INCORPORATION.

Chapter 117.

COMMONWEALTH OF MASSACHUSETTS.

IN THE YEAR ONE THOUSAND EIGHT HUNDRED AND EIGHTY.

AN ACT to Incorporate the American Bell Telephone Company. Be it enacted by the Senate and House of Representatives, in General Court assembled, and by the authority of the same, as follows: —

SECTION 1. Alexander Graham Bell, William H. Forbes, George Z. Silsbee, Richard S. Fay, Alexander Cochrane, George L. Bradley, Francis Blake, Jr., Thomas Sanders and Charles Eustis Hubbard, and their associates, may associate themselves and organize a corporation, according to the provisions of chapter two hundred and twenty-four of the acts of the year eighteen hundred and seventy, and the acts in amendment thereof and addition thereto, for the purpose of manufacturing, owning, selling, using and licensing others

to use electric speaking telephones and other apparatus and appliances pertaining to the transmission of intelligence by electricity, and for that purpose constructing and maintaining by itself and its licensees public and private lines and district exchanges, with a capital stock exceeding one million of dollars and not exceeding ten millions of dollars.

SECTION 2. For the purposes aforesaid, said corporation may become a stockholder in, or become interested with other corporations hereafter organized for like purposes, or already established for the transaction of telephonic business under its patents and no others: provided, that said corporation shall not become a stockholder in any other corporation doing business in this State to an amount exceeding thirty per cent of the capital stock of said last-named corporation. And it and its licensees may, within this Commonwealth, enjoy the rights given by chapter sixty-four of the General Statutes and acts amendatory thereof, and shall be subject to the liabilities therein imposed; but section ten of said chapter shall only apply to their public lines; and the apportionment provided by section five of chapter two hundred and eighty-three of the acts of the year eighteen hundred and sixty-five, and acts amendatory thereof, shall be made upon the number of telephones in use by it, or under its authority, or with its permission, or under Letters Patent owned or controlled by it, within and without this Commonwealth, respectively; and the returns to be made under said act shall state the facts required for such apportionment in such form as the tax commissioner may determine; and it shall be the duty of said tax commissioner or his deputy to annually examine the books, accounts and papers of said corporation, so far as may be necessary for the verification of said returns.

SECTION 3. When an injury is done to a person or to property by the posts, wires, telephones or other apparatus of the corporation, caused by any negligence on the part of itself or its officers, or on the part of any of its agents, servants, employés or operatives, the corporation shall be responsible in damages to the party injured.

SECTION 4. The franchise or charter of said corporation shall not be sold or offered for sale, or leased to any company, or to any person or association of persons, without the consent of the Legislature; and any contract made contrary to the provisions of this act shall be void. And this charter may be revoked by the Legislature for any cause which they deem sufficient.

SECTION 5. The provisions of the first and second sections of the three hundred and tenth chapter of the acts of the year eighteen hundred and sixty-eight shall apply to said telephone company and its licensees. Said corporation shall be subject to all general laws that now are or that may be hereafter in force relating to similar corporations, so far as the same shall not be inconsistent with the provisions of this act.

SECTION 6. This act shall take effect upon its passage.

HOUSE OF REPRESENTATIVES, March 12, 1880.

Passed to be enacted.

CHARLES J. NOYES, *Speaker.*

IN SENATE, March 17, 1880.

Passed to be enacted.

ROBERT R. BISHOP, *President.*

March 19, 1880. Approved.

JOHN D. LONG.

SECRETARY'S DEPARTMENT, BOSTON, March 19, 1880.

A true copy.

Witness the seal of the Commonwealth.

[SEAL]

HENRY B. PEIRCE,
Secretary of the Commonwealth.

COMMONWEALTH OF MASSACHUSETTS.

No. 1077.

Be it known that whereas W. H. Forbes, George L. Bradley, G. Z. Sillsbee, Charles Eustis Hubbard, Francis Blake, W. G. Saltonstall, Richard S. Fay, R. W. Devonshire, Charles Emerson, Thomas B. Bailey and C. M. Whitcomb have associated themselves with the intention of forming a corporation under the name of the American Bell Telephone Company, for the purpose of manufacturing, owning, selling, using and licensing others to use electric speaking telephones, and other apparatus and appliances pertaining to the transmission of intelligence by electricity, and for that purpose constructing and maintaining, by itself and its licensees, public and private lines and district exchanges, with a capital of seven million three hundred and fifty thousand dollars, and have complied with the provisions of the statutes of this Commonwealth in such case made and provided, as appears from the certificate of the President, Treasurer and Directors of said corporation, duly approved by the Commissioner of Corporations, and recorded in this office:

Now, therefore, I, Henry B. Peirce, Secretary of the Commonwealth of Massachusetts, do hereby certify that said W. H. Forbes, G. L. Bradley, G. Z. Silsbee, C. E. Hubbard, F. Blake, W. G. Saltonstall, R. S. Fay, R. W. Devonshire, C. Emerson, T. B. Bailey and C. M. Whitcomb, their associates and successors, are legally organized and established as and are hereby made an existing corporation under the name of the American Bell Telephone Company, with the powers, rights and privileges, and subject to the limitations, duties and restrictions, which by law appertain thereto.

Witness my official signature hereunto subscribed, and the seal of the Commonwealth of Massachusetts hereunto affixed this seventeenth day of April, in the year of our Lord one thousand eight hundred and eighty.

(Signed) HENRY B. PEIRCE,

[SEAL] *Secretary of the Commonwealth.*

COMMONWEALTH OF MASSACHUSETTS.
SECRETARY'S DEPARTMENT, BOSTON, Oct. 13, 1880.

I hereby certify that the foregoing is a true copy of the certificate of incorporation of the American Bell Telephone Company, organized under the provisions of chapter two hundred and twenty-four of the Acts of the year eighteen hundred and seventy, and chapter one hundred and seventeen, of eighteen hundred and eighty, having "the force and effect of a special charter," as appears by the records of this department.

Witness the seal of the Commonwealth.

HENRY B. PEIRCE,
[SEAL] *Secretary of the Commonwealth.*

Copy of the last clause of Section 11, *of Chapter* 224, *of the Acts of the year eighteen hundred and seventy.*

"The Secretary of the Commonwealth shall sign the same, and cause the seal of the Commonwealth to be thereto affixed, and such certificate shall have the force and effect of a special charter, and be conclusive evidence of the organization and establishment of such corporation. The Secretary shall also cause a record of such certificate to be made, and a copy of such record, duly certified, may, with like effect as the original certificate, be given in evidence to prove the organization and establishment of such corporation."

COMMONWEALTH OF MASSACHUSETTS.
SECRETARY'S DEPARTMENT, BOSTON, Oct. 18, 1880.

I hereby certify that the foregoing is a true copy of the last clause of Section 11, of Chapter 224, of 1870, and is now in force, and that the certified copies of record hereto annexed are the copies in said section referred to.

In testimony whereof, witness my hand and the seal of the Commonwealth hereunto affixed.

HENRY J. COOLIDGE,
[SEAL] *Deputy Secretary of the Commonwealth.*

EXHIBIT DECREE IN SPENCER, CASE, C. H. S., SPECIAL EXAMINER.

CIRCUIT COURT OF THE UNITED STATES.

DISTRICT OF MASSACHUSETTS.

IN EQUITY.

AMERICAN BELL TELEPHONE COMPANY ET AL.

v.

ALBERT L. SPENCER ET AL.

DECREE.

This cause came on to be heard upon the bill, answer, replication and proofs, and was argued by counsel and considered by the Court, whereupon it is now, to wit, Aug. 27, 1881, ordered, adjudged and decreed that Alexander Graham Bell is the original and first inventor of the invention specified in the fifth claim of the patent numbered 174,465, granted to said Bell, March 7, A. D. 1876, and the fifth, sixth and eighth claims of the patent numbered 186,787, granted to said Bell, Jan. 30, 1877, being the claims in respect of which the proofs were taken; that the said patents are good and valid patents therefor; and the complainants waiving a reference to a master to ascertain profits and damages, and accepting nominal damages, it is further ordered that the defendants pay to the plaintiff the sum of one dollar as profits and damages, and also costs taxed at , and that they be perpetually enjoined from further infringing the said patents.

By the Court,

ALEX. H. TROWBRIDGE,
Deputy Clerk.

Attest: ALEX. H. TROWBRIDGE,
Deputy Clerk.

EXHIBIT DEFENDANTS' INCORPORATION, C. H. S., SPECIAL EXAMINER.

UNITED STATES CIRCUIT COURT.

SOUTHERN DISTRICT OF NEW YORK.

IN EQUITY.

AMERICAN BELL TELEPHONE COMPANY ET AL.

v.

OVERLAND TELEPHONE COMPANY ET AL.

STATE OF NEW YORK,
CITY AND COUNTY OF NEW YORK, ss.

We, the undersigned, Seth R. Beckwith, of the city of Washington, in the District of Columbia; Robert G. Dun, of the City, County and State of New York; Sylvanus C. Boynton, of the same place; J. Newton Ewell, of the same place; John W. Barrow, of the same place; Erastus Wiman, of Staten Island, in the County of Richmond and State of New York; Peter P. Pope, of the City of Brooklyn, in the County of Kings and State of New York; Jacob Moeser, of the same place; and Charles P. Crosby, of the City, County and State of New York, pursuant to and in conformity with the Act of the Legislature of the State of New York passed on the twelfth day of April, one thousand eight hundred and forty-eight, entitled "An Act to provide for the Incorporation and Regulation of Telegraph Companies," and the several acts of the said Legislature amendatory thereof and supplementary thereto, do hereby associate ourselves together and form a company, for the purpose of carrying on the business hereinafter mentioned.

1. The objects for which the company is formed are as follows, namely: For the purpose of buying, constructing, owning, using and maintaining in a line or lines of electric telegraph within the limits of the State of New York, and also beyond the limits thereof, and in furtherance of such purpose making, buying, selling using and operating patents, inventions, machines and devices for the applica-

tion of electricity to the transmission of words, signs, sounds and messages.

2. The corporate name of said company is hereby declared to be "The Overland Telephone Company."

3. The general route to be followed shall be from the city of New York in the State of New York to the city of Albany in said State, and from there to the city of Buffalo in said State, and generally over and along the streets, alleys, roads, highways, lots, squares and other outer subdivisions of the counties, towns, villages and cities in the State of New York, with the right and privilege of extending said route beyond the limits of said States, and into and across other States and Territories of the United States, and into, across and through the other countries composing the Western Hemisphere.

4. The amount of the capital stock of the said company shall be the sum of one million dollars, and the number of shares into which the capital stock shall be divided shall be ten thousand, of one hundred dollars each, and the said company shall have the power to hereafter increase its capital stock from one million dollars to ten millions of dollars, in shares of the par value of one hundred dollars each, if it be thought expedient to do so by the board of directors, and if the holders of a majority of the stock of said company as shown by its books shall in writing consent in advance to such increase.

5. The names and places of residence of the shareholders and the number of shares of the said capital stock held by each of them respectively are as follows:—

Seth R. Beckwith, a resident of the city of Washington, in the District of Columbia, seven thousand two hundred shares.

Robert G. Dun, a resident of the city of New York, in the State of New York, seven hundred and eighty-one shares.

Sylvanus C. Boynton, a resident of the city of New York, in the State of New York, four hundred and sixty-nine shares.

J. Newton Ewell, a resident of the city of New York, in the State of New York, three hundred and thirteen shares.

John W. Barrow, a resident of the city of New York, in the State of New York, two hundred shares.

Erastus Wiman, a resident of Staten Island, in the State of New York, three hundred and twelve shares.

Peter P. Pope, a resident of the city of Brooklyn, in the State of New York, three hundred and thirteen shares.

Jacob Moeser, a resident of the city of Brooklyn, in the State of New York, one hundred shares.

Charles P. Crosby, a resident of the city of New York, in the State of New York, three huudred and twelve shares.

6. The time of the existence of the said company shall be as follows: that is to say, from the date of the filing of this certificate, as provided by law, until the first day of January, one thousand nine hundred and thirty-three.

In witness whereof, we have severally made and signed this certificate, and have hereunto set our hands and seals, the twenty-first day of February, in the year one thousand eight hundred and eighty-three.

SETH R. BECKWITH L. S.
ROBERT G. DUN L. S.
ERASTUS WIMAN L. S.
SYLVANUS C. BOYNTON L. S.
J. W. BARROW L. S.
J. N. EWELL L. S.
PETER P. POPE L. S.
J. MOESER L. S.
CHARLES P. CROSBY L. S.

STATE OF NEW YORK,
CITY AND COUNTY OF NEW YORK, ss.

On the twenty-first day of February, A. D. one thousand eight hundred and eighty-three, before me, the undersigned, a notary public in and for the State of New York, duly appointed, commissioned and sworn, and dwelling in the county of Kings, personally appeared Seth R. Beckwith, Robert G. Dun, Sylvanus C. Boynton, J. Newton Ewell, John W. Barrow, Erastus Wiman, Peter P. Pope, Jacob Moeser and Charles P. Cr sby, each and all to me pensonally known, and known to me to be the individuals described in and who executed the foregoing certificate or instrument, and they severally acknoweledged to me that they executed the same.

In witness whereof, I have hereunto set my hand and affixed my notarial seal the day and year above stated.

[L. S.] WM. THORP,
Notary Public, Kings County.

Certificate filed in N. Y. County.
Filed and recorded Feb. 21, 1883, 3 h. 54 m.

STATE OF NEW YORK,
CITY AND COUNTY OF NEW YORK, ss.

I, Patrick Keenan, clerk of the said city and county, and clerk of the Supreme Court of said State for said county, do certify that I have compared the preceding with the original certificate of incorporation on file and record in my office, and that the same is a correct transcript therefrom, and the whole of such original.

In witness whereof, I have hereunto subscribed my name and affixed my official seal this seventh day of March, 1883.

[SEAL] PATRICK KEENAN,
Clerk.

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EXHIBIT OVERLAND TELEPHONE COMPANY PAMPHLET,
CHAS. H. SWAN, SPECIAL EXAMINER.

THE

Overland Telephone Company,

171 BROADWAY, NEW YORK.

OFFICERS.

R. G. Dun,	President.
J. W. Barrow,	Vice-President.
J. N. Ewell,	Treasurer.
Charles P. Crosby,	Counsel.
R. D. Buchanan,	Secretary.
Dr. S. R. Beckwith,	Gen'l Manager.
Benjamin Thompson,	Electrician.

DIRECTORS.

R. G. Dun,	Erastus Wiman,
J. W. Barrow,	Charles P. Crosby,
J. N. Ewell,	S. C. Boynton,
S. R. Beckwith,	A. H. Welch.
F. W. Lockwood.	

APITAL STOCK, ... $1,000,000

(With permission to increase to $10,000,000.)

NEW YORK:
Jones Printing Company, 42 Broad Street.
1883.

THE OVERLAND TELEPHONE COMPANY

Has purchased the patents of Dr. Myron L. Baxter, of Washington, D. C., for improvement in telephone transmitters and telephone receivers. These patents were issued May 8, 1883, and are believed to be entirely new devices for the transmission of the human voice.

Experiments have been made with this telephone over a distance of nearly 800 miles, and conversation can be carried on as readily as the usual telephonic conversations in large cities by the telephones now in use.

After the Overland Telephone Company had made these practical tests, they employed experts to examine the system, for the purpose of determining whether the patents were an infringement upon any other known patent, and these learned experts have given an unqualified opinion as to its being a new departure, and filling a vacancy never before occupied in telephony and telegraphy.

At present a contract exists between the Bell Telephone Company and the Western Union Telegraph Company, by which the former are only allowed to use telephones and the latter only telegraphic instruments. By this unfortunate combination, so far as the public is concerned, small villages have never been placed in telegraphic communication with the world.

The Overland Telephone Company, recognizing this want, have determined to fully supply it, and for that purpose have organized a majority of the States into separate companies, known as branches of the Overland Telephone Company of New York.

There is at present owned by these companies a franchise giving to the several companies the right to erect poles throughout the different States and Territories for the purposes of telephoning and telegraphing.

The aggregate capital of these companies already organized, and those in process of organization, amounts to over $12,000,000.

Having thus obtained these important franchises, the Overland Telephone Company now proposes to commence the erection of poles and lines, also the establishment of telephone exchanges in all the principal cities, towns, and villages, for the purpose of through and local business throughout the country.

The object to be attained will readily be seen when it is known that more than one half of the population of this country are not in the immediate reach of any telegraph office, as it requires a village of at least 1,500 inhabitants to support one.

By the plan adopted by this company, the smallest villages, and even the individual farmer, can have a telephone connected with the main line, and thus communicate with cities where dispatches can be conveyed to any part of the world, by telegraph or by telephone.

By this plan, also, the telegraphic business of the country will be largely increased, thereby allowing the company to make reasonable profits on its investment, at the same time placing the rates for messages far below anything heretofore known. It costs on an average $60 per mile for the erection of poles, wires, insulators, &c. The additional expense in neighborhoods where telephonic communication is required would be simply the expense of cross-wire to any place where a telephone is needed. If it is intended for public use, unskilled labor can be employed at moderate salaries and the whole expense of locating an office, including wires, instruments, &c., would not exceed, on an average, $100.

Again, another advantage to be accomplished by the combination of telephones with telegraphy is, that unskilled and cheap labor can be employed, so that in no instance could a strike occur among the operatives.

Had the Overland System of Telephony and Telegraphy been established during the late strike, the business of the country would not have been interrupted for a day, as its long distance telephone could, by relays, have carried on the entire business of the country by persons who had never before had experience in the use of the instruments.

The reason why telephone and telegraph companies have not been heretofore established is that Dr. Baxter was the first to invent a telephone constructed so as to convey speech by a "*make and break*" current, in a similar manner that sound is conveyed in telegraphy, thereby enabling conversation to be carried on between extreme points, as is now being done by this new telephone.

The short circuit telephone heretofore used has been controlled by a monopoly of capital, and by such shrewd management that all previous efforts to organize competitive companies has been prevented. In the case of Prof. Gray's telephone, his invention was purchased at a large price, and became oblivious just at a time when it was proposed to put it into public use.

The Edison telephone, owned by the Western Union Telegraph Company, after a large number of offices had been established, consolidated with the Bell Company, as heretofore stated, and the public was again dependent upon the Bell monopoly for its use of the telephone.

The workings of this monopoly is forcibly expressed by the celebrated Prof. William F. Channing, M. D., in his article "The Telephone," in the August number of *The Popular Science Monthly:*

"The telephone outranks all previous discoveries in its direct enlargement of human power. The telescope and microscope are its nearest compeers. The telegraph beside it is a clumsy mechanism. The telephone, which makes a whispering gallery of the round earth, may well exert an influence on civilization comparable with that of the railroad and steamship. Already the business centres expand and the values of city lands change under the magic of an invention which places every man at every other man's ear. But this promise or prophecy of the telephone is not all that effects the interests of the American people. There is a menace in connection with its present history which justly awakens public concern. Rapacious hands have clutched the throat of the telephone to extort oppressive tribute for every word which it utters."

Capital has been timidly withheld from being invested in new telephone companies, as the most boastful claims have been made by this monopoly in its statements of having secured favorable legal decisions in numerous cases, while in fact, so far as we have been able to learn, not one case of priority of claims has been thoroughly contested in any court of justice. As evidence of the manner of reporting these so-called legal decisions we quote from the *Newark Advertizer:*

TWO SIDES OF A QUESTION.

The interpretation of a recent telephone case as sent to the Associated Press for circulation:

TELEPHONE PATENTS UPHELD.

TRENTON, March 28. — In the United States Circuit Court, to-day Judge Nixon made an important decision in the case of the Bell Telephone Company against Andrew Albright and John J. Ghegan, of Newark. Ghegan claimed to have invented a telephone which was used by the People's Telephone and Telegraph Company, and a line was run from the office of the company to the store and residence of Andrew Albright in Newark. A suit was brought against them by the Bell Telephone Company for infringement, and the case was tried some time ago. The validity of the Bell patents was assailed, and a very strong contest resulted. To-day Judge Nixon made an order which sets forth that the two patents granted to Alexander Graham Bell on March 7, 1876, and January 30, 1877, are good and valid patents, and that the defendants, combining and confederating with the People's Telephone and Telegraph Company, have infringed the same; that it be referred to D. C. Oliphant to ascertain the damages sustained by the Bell Company, as well as the profits and gains of defendants for the use of the infringing instrument. Further, that a perpetual injunction be issued restraining the defendants and all others from further infringing the said Letters Patent. It is stated that the case will be carried to the United States Supreme Court.

The facts of the case as reported by a local Newark paper:

THE TELEPHONE CASE.

The case of the Bell Telephone Company against Messrs. Albright and Ghegan, of this city, was not decided on the merits of the controversy. Ghegan did not claim that he had invented a telephone. He used the Hopkins instruments under a contract with the People's Telephone and Telegraph Company. Mr. Albright also used one. The Bell Company brought suits for infringement, and, on the application for injunction against Ghegan, he made defence, but soon afterwards went to Mexico, and the People's Company failing to maintain his defence, no other opposition was made. The evidence for the plaintiff was taken in Boston. No person appearing for the defendant, no evidence in defence was taken, and on the case being called at the opening of the term, no counsel appeared either for Ghegan or Albright, and the court ordered a reference and injunction, as of course. The case, being thus practically undefended, settles very little as to the questions involved in the telephone controversy.

The late decision in the interference case in Washington takes from this monopoly even its claim of priority on receiving telephones.

This monopoly, no longer shielded by the courts, cannot be expected to govern and control the business without fair competition. The excessive prices heretofore charged for the use of the telephone have placed it beyond the reach of the majority of those requiring its use. The yearly rental of one instrument in large cities ranges from $80 to $150.

The Overland Telephone Company proposes, in the establishment of its organizations, to sell its telephone at a fair profit above cost, and to give efficient service through such organizations at such a price as will bring its use within the reach of all. By this means, more than twice the number of instruments now used can be introduced, and the service will be proportionally more valuable.

The Overland Telephone Company, charging no royalty on its patents, allows each sub-company and organization to establish their companies and exchanges on such a liberal basis that these reduced rates can be maintained, and still enable the business to pay a fair dividend.

If the number of telegraph and telephone wires now in existence were estimated at $60 per mile, one fifth of the present capital would build and furnish the same amount of telegraphic and telephonic communication. At one half the rate charged, and with one fifth of the capital invested, the profits to the investor would be found to exceed those which now exist.

The first questions that arise in the mind of any one desiring to engage in a new enterprise of this kind are:

1. Is the devise used new and novel?
2. Will it accomplish all that is claimed for it?
3. Does it infringe upon any other patented device?

We will now endeavor to answer these questions *seriatim*

1st. In the transmitting instrument, which is entirely new, we have an electro-magnet which governs the pressure between the poles of the battery, by which means variations in the tone of speech may be reproduced accurately between any two points, enabling us to employ, in long distance telephoning, sufficient battery power, which cannot be done by any other system in existence. In our receiving instrument, we have a principle of great novelty, consisting of a compound magnet, which amplifies sound many fold above any other receiving instrument heretofore used.

2d. The annexed extracts and statements are all that is required on this point;

The *National Republican*, Washington, D. C., March 17, 1883, says, through its correspondent, who witnessed the Telephone test, under the head of "The Telephonic Wonders":

"It has at last been demonstrated that a man at a telephone can converse with another seven hundred and fifty miles away. Baxter's telephone was tested last Monday between New York and Cleveland, Prof. Thompson having charge of the experiments at New York and Prof. Buell, of this city, at Cleveland. The conversations were carried on from Monday to Wednesday, inclusive, and were purposely made severe. The results were entirely conclusive of the practicability of the system.

The *Evening Stock Report* of March 22, 1883, under heading "A National System of Communication by Telephone," says:

"Dr. Baxter, of the United States War Department, may be said to have revolutionized the system of telephonic communication now in use. Recognizing that the ordinary undulatory current used in the telephone was insufficient to overcome the resistance offered to its passage over a long circuit, and the effect of induction which even for short distances frequently renders the ordinary telephone useless, he turned his attention chiefly to the means of augmenting it, and devised an arrangement by which the entire current of the line battery was thrown into the wire . . . also, by an ingenious mechanism, has arranged the entire apparatus so that the vibrations of the voice upon the transmitting diaphragm make and break the current, just as at present the sounder works by the 'make and break,' only, instead of the message being delivered by the ordinary taps of the telegraph key, the articulations of the voice become loud and distinct. The representative of the *Stock Report* conversed with a party on Fourteenth Street from the Overland Telephone Company's office, and the conversation was as audible and distinct as if talking with a person in the same room."

The *Commercial World* of New York, states, in an editorial on the working of the Overland Telephone Company:

"The value to the community, let alone to the merchant, who will be enabled by this system to converse with Chicago as readily as he now talks with his neighbor a few streets away, is so incalculable that we shall take care to report the progress of the company, who have our hearty wishes for their success, from time to time, and we trust the period is not far distant when the skill of the operator will no longer be required to render the iron bonds which join distant parts of the country available to all.

"Practical tests have been made with these instruments by the company that were of the utmost importance as a promise of the future success of their operation. They were able to converse over a distance of 700 miles by means of a 12-cell battery current."

The *Baltimore American* of May 3d, 1883, says, in speaking of the Overland Telphone Company, that one of its representatives had a pleasant chat with the operator in Washington, forty miles distant, the talking being done in an ordinary tone of voice, without a word being missed at either end of the line, and without there being any occasion for repetition. Even when the voices were lowered to a whisper the sounds came with entire distinctness; although at the Baltimore & Ohio Telegraph rooms the wire was connected to a switch-board close alongside of one hundred wires; yet there was no induction worth mentioning, although the electric light currents were on during the latter part of the test.

3d. The Bell Telephone Company's patents claim telephones operated upon the principle of undulatory currents, while ours are not, as explained in the following opinion of one of the most able experts in the country:

If a current from a battery is flowing in circuit with a carbon transmitter, and *in the same* circuit with a receiving telephone, the current received will be varied by the variation of contact between the electrodes, and will be a true undulatory current, because its flow will be increased and diminished alternately, but *will always be in the same direction*, — rising and falling, — always flowing, just as a stream of water flowing through a rubber tube can be made undulatory by alternately pinching the middle of the tube more or less between the thumb and finger. The annexed illustrations show arrangement for obtaining a true undulatory current:

FIG. 1.

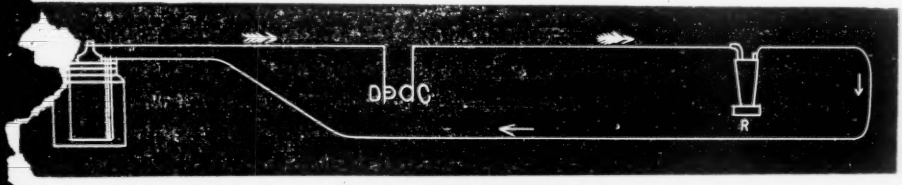


FIG. 2.

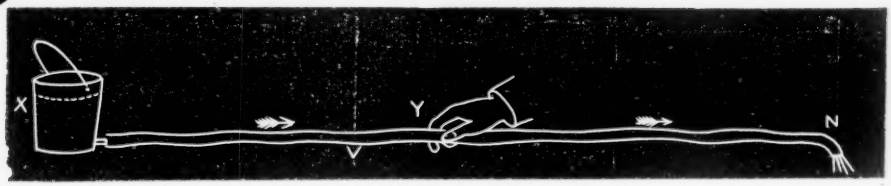


FIG. 1.— B, battery. Arrow shows direction of current. D, diaphragm. C, carbon button. R, receiver.

FIG. 2.— X, jar of water. Arrow shows direction of flow. Y, compression by the hand in place of the electrical transmitter. N, place where undulations in stream of water may be seen. V, rubber tubing.

The analogy between the above is evident. If this were the way the Overland system worked, Baxter should have to admit that he used the undulatory current. But he does not.

The receiver is not in circuit with the battery or the transmitter, and therefore not operated by what has been admitted to be an undulatory current.

The receiver is operated by another current *derived by induction* from the undulatory current. Even then, if this derived current is undulatory, Baxter gains no advantage, for his receiver would be operated by *un*-undulatory current; but Baxter's claim is that the second current is *not* undulatory in its character, but intermittent or pulsatory.

In proof of this the following may be urged:—

An assertion that a new current or series of currents, resulting from changes in the admitted undulatory current, must be undulatory, because the current from which it is derived is undulatory, is untenable. It might as well be argued that, because the flow of water in a stream is in a straight line, the motion of a wheel operated by it would not be rotary.

In considering the matter, a full understanding of the circuits should be had. They may be represented as follows:

FIG. 3.

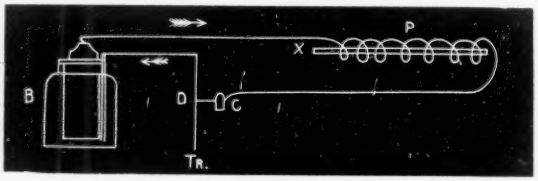
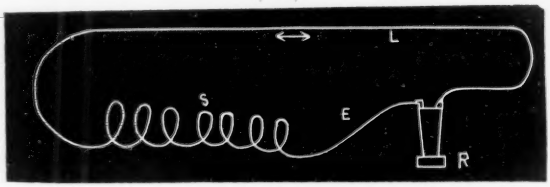


FIG. 4.



(FIG. 3) B, the battery. Current always flowing in the direction of the arrows. D, Diaphragm. C, Carbon button; together they form the transmitter. P, A solenoid; a coil of wire wound on an iron core X. These form the local circuit. The secondary or line circuit is made up as shown, (FIG. 4) of S, a larger solenoid or hollow coil, which in practice is slipped over and incloses P, but the two circuits are never in true electric contact. They are, in fact, insulated from each other as perfectly as possible. Bear in mind that the battery current never enters upon the line circuit, but is confined to the station where the transmitter is located. L is the line wire, say ten miles long, and R the receiver. The wire E may be replaced by the earth.

Suppose now that the battery current is flowing *evenly* through C, D. There will be a current, and perhaps a very strong one, in the local circuit through P, but so long as it flows without change *there is no current in S, L, R, E.*

The moment, however, that any disturbance occurs at D, C, an intense induced current springs into being, and rushes out upon the line to the receiver, and that impulse dies. Another disturbance creates another current of like character, and it immediately dies.

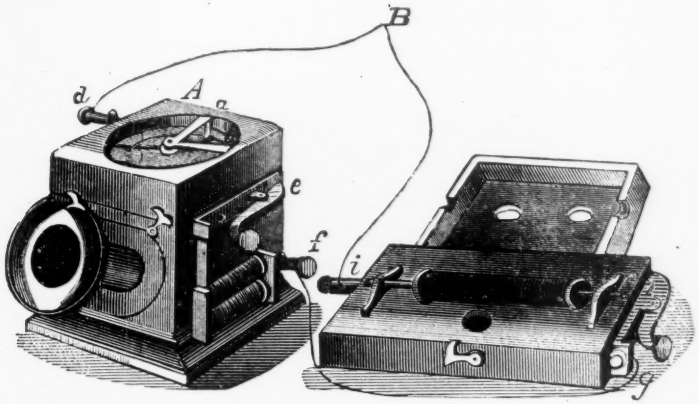
Even if these intermittent currents all traversed the line wire L in one direction, it would not be difficult to prove that they are intermittent and not undulatory. They would be like a great number of projectiles following in close succession, or like blowing beans through a bean shooter. But to render the demonstration still clearer, and to show that there is *a succession of currents* and not an undulatory one, alternate currents are known to traverse the line wires *in opposite directions.* Whenever the pressure between the electrodes at *D, C,* is increased, a current is *started* in the line wire in a certain direction, and whenever the pressure is diminished *another* current is started in the line in the opposite direction; and so it goes on with the vibration of the diaphragm, every motion giving rise to a new current of either the one or the other polarity or direction.

These are induced currents, and result from of the *influence* P and X upon S (Figs. 3 and 4).

A large number of separate and distinct currents, rapidly succeeding one another and going in opposite directions, bear little resemblance to an undulatory current flowing constantly in one direction, never ceasing, only rising and falling.

The last decision in the Interference case, and the fact that the Overland Telephone Company now represents so many millions of dollars, and stands ready to protect and defend all its rights and claims, together with legal opinions of the most intelligent experts of the country in reference to its validity, is sufficient answer to this question; but, if any party or parties should make any effort or attempt to enjoin or interfere with our business, the Overland Telephone Company will give bonds, and not allow any interruption or interference whatever.

There is not a question of doubt that the *original* telephone, as used at present, both in England and America, was invented by Johann Philipp Reis, of Gelnhausen, Germany. In his prospectus of 1863, accompanying telephones constructed for him and sold by W. Albert, of Frankfort, he describes the following telephone with a correct representation of his instrument: —



A.—Is the Transmitter; *B.*—Location of Battery; *i. h. g.*—The Receiver, consisting of an electro-magnet, placed within a sounding box, whose core is in metallic contact with the box, whereby all electrical changes within the core of the magnet are made audible by the sounding board. In the transmitter, one of the poles of the battery *B* is connected to the "*Hammerchen*," as Reis called it, or little hammer, poised on the supports *a*, *b*, and resting *by gravity* on the strip of platinum foil at the centre of the tympanum (diaphragm) seen below. A little drop of mercury makes a perfect electric contact between the little hammer and neigh-

boring screw cup. "The elastic feature of this loose contact arrangement is confined to the animal or other membrane of the tympanum itself; the mouth-tube communicates with the inside of the box or air chamber, and the sound waves act upon the tympanum from below. On the side of the box are seen a telegraph key *e*, and sounder, for signalizing between the transmitting and receiving stations. This is the transmitter successfully used by Yeates in Dublin, in 1865. So sensitive was this transmitter that it was found unnecessary to speak directly into its mouth-piece; and in practice the speaker talked and sang at a little distance from it. In the reports of experiments with this instrument, the rattling noises which were sometimes complained of as heard in the receiver were undoubtedly due to the complete breaking of the circuit by too loud talking or singing in the mouth-piece. The Berliner and Blake transmitters [used by the Bell Telephone Co.] are liable, unless specially guarded, to the same misadventure from the same causes."

In his patent of March 7, 1876, Bell gives this method by which undulatory currents may be produced: "For instance, let mercury or some other liquid form part of a voltaic circuit then the more deeply the conducting wire is immersed in the mercury or other liquid, the less resistance does the liquid offer to the passage of the current. Hence the vibration of the conducting wire in mercury or other liquid included in the circuit occasions undulations in the current." This is precisely what Reis employed to produce the undulatory current [see preceding page] years before Bell had even thought of such a thing as a telephone.

Professor Sylvanus P. Thompson, of London, England, in the conclusion to his argument, remarks, "That there is not in the Telephone exchanges of England to-day, any single telephone to be found, in which the fundamental principles of Reis' telephone are not the essential and indispensable features." Professor Channing states that in "the light of historic facts, the decisions of the courts of the United States that Professor Bell is the discoverer of a new and useful art, (the electrical transmission of speech), to which he has exclusive title, must be reversed as speedily as possible, that our courts may retain the respect of the people of the United States."

By referring to the printed decision of the examiner in the "speaking telephone interferences," pages 48, 49, 64, 65, 344, 345, and 348, it will be seen the validity of the patents covering the Blake transmitter and the Bell receiver (the combination used by the American Bell Telephone Company) is denied, and priority awarded to other American inventors.

It is evident, in the light of all the facts herein presented, that Bell never had a first or legal claim to his telephone, it being, so far as electrical prin-

ciples are concerned, but a copy of the Reis, which was publicly used and sold in Europe 13 years before Bell made an application for a patent. It will also be observed that all the telephones made and sold by the American Bell Telephone Company are not constructed according to the specifications in the Bell patents [see Patents 174,465 and 186,787], and every so claimed legal decision has been based upon a patent whose specifications have never been followed in the manufacture of any telephone ; and again, if the Bell patent was new, both his receiver and the Blake transmitter were invented by other American inventors, as so held by the United States Patent office in the July, 1883, interference case.

Never in the world's history can be found another instance where monopoly of capital has crushed out inventive genius, awed down capital, and deprived the people of the advantage of competition, perverted the facts in legal decisions, and from the beginning until now, exacted exorbitant price for a needed public service, the monopoly not having even a semblance of a shadow to their claimed legal right.

Some of the Advantages of the Baxter Telephone

over and above any other Telephone now in use :

First. — Being of simpler construction than any other telephone, it is less liable to get out of repair.

Second. — Communications through this telephone can be received in the lowest whisper, or in the loudest tones of voice, as the instrument adjusts itself to accommodate these different volumes of sound.

Third. — In addition to the advantage of its being a long distance telephone, is the further advantage that a continuous current of electricity is converted into a make and break current by the voice upon the diaphragm.

Fourth. — A large number of cells can be used with each transmitter, thus overcoming induction, which has heretofore prevented the free and practical use of telephones in large cities.

Fifth. — It is the only telephone where an increased number of cells conveys the human voice with accuracy in cities and over long distances generally ; for example, in conversing between New York and Cleveland, it required twelve cells, while three would answer the purpose between New York and Philadelphia.

Sixth.—The Baxter telephone is the only telephone that can be successfully used with an underground wire, as has been proven by recent experiments in Philadelphia, where whispers and the ticking of a watch were heard, while working through the Brooks Underground Cable, over ninety

miles long, from the offices of the Pennsylvania Overland Telephone Company, which were connected with the cable by an aerial wire of one mile, without a metallic circuit.

The purpose of the Overland Telephone Company is to operate from the home office, in the city of New York, and vicinity, and through its organizations, the balance of the country. It will also furnish private wires to the principal cities throughout the country.

Persons desiring to organize sub companies in the New England States will address the Eastern Overland Telephone Company, No. 2 Wall street, New York.

For New Jersey, address B. F. Roby, Secretary, 784 Broad street, Newark, N. J.

For the Northwest, address Haines & Southerland, No. 101 Washington street, Chicago, Ills.

For the Middle States, The Penn Overland Telephone Company, No. 39 South Tenth street, Philadelphia, Pa.

For Ohio and Indiana, address the Ohio Overland Telephone Company, No. 36 Wiggins Block, Cincinnati, Ohio.

For the Southwest, address Henry U. Frankel, Louisville, Kentucky.

For the Pacific Slope, address George H. Roe, Esq., San Francisco, California.

For Canada, address J. W. Currier, Esq., Montreal, Canada.

DEPOSITION OF DANIEL M. ADEE.

Direct Examination by GEORGE L. ROBERTS, Esq., *of Counsel for Complainants.*

BOSTON, Nov. 28, 1883.

Int. 1. State your name, age, residence, and occupation.

Ans. Daniel M. Adee; I am thirty-seven years old; I live in Brooklyn, L. I., and am the adjuster of the Metropolitan Telephone and Telegraph Company of New York.

Int. 2. What are your general duties as adjuster, and what experience have you had in time past with electrical subjects and instruments?

Ans. My duties as adjuster are to investigate troubles of all kinds, or disputes which may arise between the company and its subscribers, such as imperfect service, claims for deductions from their accounts by reason of the same.

I have made the telephone a study since the spring of 1879, putting them up, and making them in the laboratory experimentally. I have patented devices for improvements in telephones and have applied for others.

Int. 3. When did you first learn of the existence of the defendant corporation, the Overland Telephone Company?

Ans. I think it was in the latter part of February, '83.

Int. 4. What investigation did you make of the doings of that corporation, and when first?

Ans. Shortly after learning of it, I called at 171 Broadway, and was introduced to their secretary, Mr. Buchanan, and Dr. Beckwith, and had the instruments shown to me by them, together with specifications in manuscript form, and rough drawings, pen sketches, which I understood to have been made by Dr. Baxter, descriptive of the instrument.

Int. 5. How were the instruments situated which were shown to you, and what examination did you make of them, and what use if any did you see them put to?

Ans. A complete set was upon the wall attached to a line. I opened the transmitter and looked into it. The bell was rung and responded to by some one who said they were in Fourteenth Street, New York. The receiver was handed to me, and examined by taking it apart.

Int. 6. You have mentioned sketches and specifications in manuscript form which were shown to you at this time: have you examined the drawings and specifications of the two patents No. 277,198 and No. 277,199, each dated May 8, 1883, and granted to Myron L. Baxter, and if so, how did the specifications and sketches so shown to you compare with the specifications and drawings of the said Baxter patents?

Ans. They were substantially the same.

Int. 7. Were the instruments which you saw connected up in condition for use designated by any name, and if so, what?

Ans. I did not notice any name or imprint upon them. I was told that they were a set of Baxter telephones, by Mr. Buchanan.

[*Counsel for defendants objects to the witness's repeating what Mr. Buchanan said upon the subject, as hearsay.*]

Int. 8. Will you look at the instrument now shown you, state what it is, and how it compares in construction with any instrument you examined at the defendant company's office on the occasion referred to?

Ans. That is a Baxter transmitter, as I understand it, and looks to be a *fac-simile* of those I saw on the wall.

[*The instrument referred to is put in evidence, and marked "Exhibit Defendants' Transmitter No.* 1."]

Int. 9. Now look at this other instrument, state what it is and how it compares in construction with any instrument you examined at the defendant company's office on the same occasion.

Ans. It appears to be the same receiver that was used on that occasion. It is the same shape. It appears to be connected up the same as the one I saw, — provided with two spools and an insulated iron ribbon in the circuit.

[*The instrument last referred to is put in evidence and marked "Exhibit Defendants' Receiver."*]

Int. 10. You have referred to Dr. Beckwith as being present at the defendant company's office on the occasion referred to: what position did he profess to hold in that company?

Ans. I was introduced to him, I believe, as general manager.

[*Answer is objected to as hearsay.*]

Int. 11. Did you make any subsequent investigation as to the location of the other end of the line from which a response came, purporting to be in Fourteenth Street, and if so, what did you find?

Ans. I called at S. E. Hibbard & Son's office in Fourteenth Street, and saw another set, which Mr. Hibbard said ran to 171 Broadway.

[*Counsel for the defendants objects to the answer as hearsay, and states that* he *warned the witness not to state what Mr. Hibbard said.*]

Int. 12. How did the transmitter and receiver at the office of S. E. Hibbard & Son compare with the transmitter and receiver which you had examined in the defendant company's office, 171 Broadway?

Ans. I don't remember any difference in them.

Int. 13. Did the defendant company continue to occupy the same office at 171 Broadway, in which you first saw its telephone instruments, and if not, where was its next office?

Ans. They moved across the hall, some time after that, in the same building.

Int. 14. Do you remember any names designated as officers of the defendant company painted on the door of its office, and if so, what?

Ans. There were a numer of names there. I do not remember them all. Mr. Buchanan's name, I do not remember his initials, as secretary; R. G. Dun as president. Dr. Beckwith, — I don't remember whether there was anything besides his name; and I think his name was on another door.

Int. 15. About when did you first visit this second office of the defendant company, and what telephone instruments, if any, did you see there?

Ans. It was shortly after they moved into the new office. I can't give you the exact date. I believe it was in the latter part of March or first of April. There was a number of instruments on the floor, and at least two or three sets upon the wall.

Int. 16. Did you ascertain where any of the lines ran to from either of these sets of instruments which were upon the wall?

Ans. I ascertained that there was one running to their instrument makers, corner of Church Street and Dey Street.

Int. 17. Who were their instrument makers, and if you visited the shop of such makers, what did you see there?

Ans. Pride, Freleigh & Kyle. I saw a number of such telephones in parts, and made up there, and one set upon the wall.

Int. 18. How did the set of telephones upon the wall of the shop of these instrument makers compare with the telephone instruments Exhibit Defendants' Transmitter No. 1 and Exhibit Defendants' Receiver; and when you say you saw "a number of such telephones in parts, and made up there," what sort of telephones do you mean?

Ans. I saw no particular difference in them; and I mean magnets and spools such as would be required to make a telephone of that kind.

Int. 19. Did you personally talk over this line between Pride, Freleigh & Kyle's shop and the defendant company's office, at No. 171 Broadway?

Ans. I spoke on the line from 171 Broadway, and had a response, but could not distinguish any voice.

Int. 20. Did you during any visit to the defendant company's office at 171 Broadway, about the last of March or first of April, 1883, hear any one of that company's officers say anything with respect to its intentions in regard to the telephone instruments such as you saw there? and if so, state who made the declaration, and what it was.

Ans. I did. Dr. Beckwith, in conversation with me, said that they were going to do business, and that they expected a fight with the Bell Telephone Company of Boston.

Int. 21. Please look at the pamphlet which I now show you and state whether you ever saw such a publication before this time, and if so when, and to what extent you know of its circulation.

Ans. I have seen one similar to that. It was sent to me. I don't know where it came from. I believe it to be the same. As to its circulation, I have no means of knowing how great it may be. I should judge it was about two months ago. I don't have any means of placing that date.

[*The pamphlet referred to is put in evidence and marked "Exhibit Overland Telephone Company Pamphlet." The pamphlet is objected to on the ground that it does not appear to have been put in circulation before the bill was filed.*]

Int. 22. Upon page 15 of this pamphlet is the following declaration: —

"The purpose of the Overland Telephone Company is to operate from the home office in the city of New York and vicinity, and through its organizations the balance of the country. It will also furnish private wires to the principal cities throughout the country." . . . "For New Jersey, address B. F. Roby, Secretary, 784 Broad Street, Newark, N. J." . . . "For the Middle States, the Penn Overland Telephone Company, No. 39 South Tenth Street, Philadelphia, Pa."

Have you investigated the acts of the defendant company at the places so mentioned in Newark, N. J., and Philadelphia, Penn.? and if so, state briefly what you have found, and the time when such investigation was made in each place.

Ans. Oct. 4, 1883, I went to Newark, N. J., and called at 784

Broad Street, and saw Mr. E. W. Smith, who said he was superintendent of the Overland Telephone Company of New Jersey. He showed me a set of instruments similar to those that I had seen at New York, of a later pattern than the former. A square box was substituted for the round in the transmitter. The receiver was just the same in pattern. He connected me with B. F. Roby's office by means of a switch. That was at 910 Broad Street, a few blocks down the street. There was upon the door at 784 Broad Street, "B. F. Roby, Secretary." I found a set of similar instruments at B. F. Roby's store, 910 Broad Street, and another at 9 Bank Street at Thomas C. Provost. The line to Provost was one of the numbers in the switch at 784 Broad Street. That is all there was in Newark.

I went to Philadelphia on the next day, and saw a set of instruments at 1001 Chestnut Street, the New York Mutual Life, marked "Overland Telephone, patented May 8, 1883, No. 277,198, 277,-199," numbered 54. I also saw a set at the corner of Chestnut and Third Streets, at David Brooks's office, numbered 67, and otherwise marked the same as the others.

I also saw several upon the wall in the office of the Penn Overland Telephone Company, No. 39 South Tenth Street. There were two sets in operation upon the wall there, and one set in an adjoining room which ran to the Mutual Life Building opposite. These were like the instruments I saw in New Jersey, and, excepting their individual numbers, were stamped like those in the Mutual Life.

[*Counsel for defendants seasonably objects to any evidence of what was done by the defendants after the case was at issue, in the nature of an admission of what was done in the way of infringement before the bill was filed, and gives notice that he will move to strike it out.*]

Int. 23. How does the instrument now shown you compare in form and construction with the transmitters mentioned by you as in use in Newark, N. J., and Philadelphia, in October last?

Ans. It is very similar in all its parts, that I see. I made this myself as nearly a *fac-simile* as I could make, so far as shape goes, and the arrangement of its parts.

Int. 24. Have you ever seen such a transmitter in use in the defendant company's office in New York, and if so, when and in what office?

Ans. No, I have not in use there, but I saw instruments like it at 158 Broadway, about the 8th of October, — the 6th to the 8th, — 1883. That is the new office of the Overland Telephone Company.

[*The instrument last referred to by the witness is put in evidence and marked "Exhibit Defendants' Transmitter No. 2."*]

Int. 25. Were the instruments, which you saw at defendants' new office, like Exhibit Defendants' Transmitter, No. 2, in October last, stamped with any designation?

Ans. I did not get near enough to them to notice any.

Cross Examination by S. S. HOLLINGSWORTH, Esq., *of Counsel for Defendants.*

Cross-Int. 26. How long have you been in the employ of the Metropolitan Telephone and Telegraph Company?

Ans. Since May 1, 1880.

Cross-Int. 27. What business were you engaged in before that?

Ans. Telephones, with the Bell Telephone Company of New York.

Cross-Int. 28. How long had you been with them?

Ans. Since somewhere along the beginning of '79.

Cross-Int. 29. What were you doing before that?

Ans. Studying medicine in New York.

Cross-Int. 30. How long were you studying medicine there?

Ans. Upwards of three years.

Cross-Int. 31. Did you finish your course there?

Ans. I did not.

Cross-Int. 32. What had you been doing before you studied medicine?

Ans. Iron and steel works at Maspeth, L. I.

Cross-Int. 33. How long were you at that?

Ans. About three years.

Cross-Int. 34. Were you the proprietor?

Ans. One of them. My father was another.

Cross-Int. 35. Had you ever paid any attention to the study of electricity prior to 1879?

Ans. Not particularly.

Cross-Int. 36. What was the nature of your duties when in the employ of the Bell Telephone Company?

Ans. Pretty much the same as my duties in the Metropolitan.

Cross-Int. 37. Describe to me a little in detail what your duties are in the Metropolitan.

Ans. I [illegible] the adjustment of claims for deduction on account of imperfect se[illegible], and to ascertain the cause of complaint and suggest remedies, and recommend any improvement if I can see it.

Cross-Int. 38. Do you personally inspect the instrument where there is a complaint, or a rebate asked?

Ans. Not unless specially requested to do so by the general superintendent.

Cross-Int. 39. Upon what *data* do you make an adjustment?

Ans. The equity in the case, if there is any, — upon my judgment.

Cross-Int. 40. What facts do you look into?

Ans. If it is a complaint of service, I look into his instrument, personally, if I think it best to do so, if not I do not; circumstances govern the case.

Cross-Int 41. Isn't your duty rather this: that where complaints are made of service or of charges for service, you ascertain from the proper officer of the company whether or to what extent the complaint is well grounded, and then make such an equitable allowance as in your judgment you think best?

Ans. I always do that first. If the subscriber does not agree with my record, when they say it is all wrong and we say it is all right, and they ask me to try it for myself, and I try it, and find a little trouble, obscure perhaps, I then at once, without questioning anybody, fix it, if I can, if not I have it fixed. I have the authority to do it if I wish.

Cross-Int. 42. How much of your time does this work take?

Ans. The greater part of my time.

Cross-Int. 43. You haven't given much attention then to the theory of electricity, have you?

Ans. Not any more than the reading of the works of the day, — not making it a particular study.

Cross-Int. 44. What works of the day have you read?

Ans. Lectures and scientific discussions by different people.

Cross-Int. 45. Do you remember the author of any of the lectures or the participators in any of the discussions?

Ans. Yes, a few, — Dolbear, Prof. Graham Bell, Prof. Cross, Du Moncel, and others of that class. Simply incidentally, as you would read anything that interests you. I haven't made it a study.

Cross-Int. 46. What works of Du Moncel have you read?

Ans. I have simply read his papers on electric light, the telephone, etc. I don't particularize any of them.

Cross-Int. 47. Have you ever been engaged in constructing electrical apparatus?

Ans. For myself, experimentally. I never made a business of it. I have made several telephone transmitters with new adjustments, such as the Hopkins transmitter, so called, which I claim to be the inventor of; and the inventor of the electric mercury switch, and a time device for attachment to a telephone as a register, and other little items of that kind, which never amounted to a great deal, because it wasn't my business to follow it up.

[*Adjourned to Friday, Dec.* 7, 1883, *at* 10 A. M., *by request of counsel for defendants, it being stipulated and agreed that complainants' time for putting in opening testimony be extended ten days beyond the time already fixed, and that defendants' time for putting in testimony in support of answer be likewise extended ten days beyond the time fixed, and that the time for rebuttal be correspondingly extended.*

Hearing further adjourned to Dec. 18, 1883, *in accordance with stipulation of counsel, dated Dec.* 6, 1883.]

BOSTON, Dec. 19, 1883.

Cross-Int. 48. When you first went to the office of the defendant company in New York, tell us what you said and what they said, whoever was there.

Ans. I don't remember exactly what I did say.

Cross-Int. 49. Didn't you represent yourself as opposed to the Bell Company?

Ans. Never.

Cross-Int. 50. Didn't you state that the Bell Company had deprived you unjustly of an invention of your own?

Ans. I never thought of such a thing.

Cross-Int. 51. When did you first read the Baxter specifications after the issue of the Baxter patents?

Ans. Somewhere about the latter part of February or first of March.

Cross-Int. 52. Are you quite positive about that date?

Ans. That is as near as I can remember.

Cross-Int. 53. And you were able then by comparison with your recollection of the rough draft you saw in February of what you say was shown to you on the occasion of your visit to the defendants, office, to note their points of similarity and dissimilarity, were you?

Ans. No, sir; I was not.

Cross-Int. 54. Have you seen that rough draft since the first time you say it was shown to you in New York, — of what you call the Baxter specification?

Ans. I have not.

Cross-Int. 55. How can you state now then that the rough draft is substantially similar to the Baxter specification?

Ans. Because the specification in the patent papers agrees with my understanding of the draft at the time.

Cross-Int. 56. Then, although you weren't able to recollect what the similarities were when you first saw the patent specification between it and the rough draft, and though you have never again seen the rough draft, you are now able to swear that they are similar?

Ans. In construction details I am.

Cross-Int. 57. What has refreshed your recollection?

Ans. A draft of my own, which I made from memory from those rough drafts, and the instruments themselves, which I saw on that day.

Cross-Int. 58. Where is that draft which you made from memory?

Ans. I sent it to the American Bell Telephone Company.

[*Defendants' counsel calls for the production of the draft referred to.*]

Cross-Int. 59. When was the draft made from memory made?

Ans. I believe it was marked "March 16, 1883." It was marked on the day it was made.

Cross-Int. 60. Have you not testified that the instruments you saw in New York were substantially similar to those described in the Baxter patents?

Ans. As I understood the Baxter patents, they were; and as near as I understood the construction of the instruments without taking them apart.

Cross-Int. 61. How do you know, without having taken the instruments apart, that their construction and mode of operation were substantially similar to that of the instruments described in the Baxter patents, and to that of the instruments marked "Exhibit Defendants' Transmitter No. 1," and "Exhibit Defendants' Receiver"?

Ans. The portions of them that I was permitted to see corresponded. The tracing of the circuits in the transmitter was about the same, so far as I can remember; the general appearance was the same.

Cross-Int. 62. You inferred then from the similarity of the portions which you saw, that the portions which you didn't see were also similar, and that the mode of operation was the same: am I correct in this?

Ans. Yes.

Cross-Int. 63. Now describe to me exactly what portions of those instruments you saw.

Ans. I saw the transmitter diaphragm, the little finger presser holding the diaphragm in the cast-iron ring. I saw the pendulum bar with the carbon button in the centre. I saw the induction spool, its primary and secondary wires running out of it, an electro-magnet on the door of the transmitter, which I traced as being in the primary circuit to the battery, and the same primary circuit through the diaphragm and swinging electrode back to the other pole of the battery. That is substantially what I could see.

The receiver was not taken apart by me there, but it was connected up in the secondary circuit, which completed the arrangement. The magnet was exposed, and I saw that and the diaphragm. All I saw of the receiver at that time was what I could see by looking at the outside of it.

Direct Examination resumed.

Int. 64. How soon after your first visit to the office of the defendant company did you have opportunity to examine the interior construction of the receiver used by it?

Ans. I should think it was about two weeks, perhaps, from the first visit.

Int. 65. Where did that opportunity occur, and what did you see with reference to the interior construction of such receiver?

Ans. I was taken to the corner of Dey and Church Streets, — 23 Dey Street, I think it was, — where I understood they were made, and there had one pulled apart in my presence sufficient to see how they were made.

I saw a horseshoe magnet, a spool of fine wire, a band of ribbon insulated with some substance, — paper, I think,— and on the outside another spool of wire connected in series, the terminal ends running to binding posts in a wooden handle; a diaphragm attached at one end of the magnet, a wooden cup holding it in place screwed over the whole. The spools that I have mentioned were on the other end of this horseshoe magnet.

Int. 66. You have heretofore referred to the defendant company's instrument makers, Pride, Freleigh & Kyle, corner of Church and Dey Streets: was this the place where you examined the receiver as mentioned in your last preceding answer?

Ans. The same.

Int. 67. How frequently since your first examination of defendants' telephone instruments at its office, and the interior construction of the receiver at the instrument makers' about two weeks afterwards, have you examined the construction of telephone instruments used by the defendants or in their possession or at their instrument makers'?

Ans. Oh, several times. I can't say just exactly how many times.

Int. 68. You say that you sent the draft which you made from memory from the rough draft of the Baxter telephone seen by you at the defendants' office, on the occasion of your first visit there, to

the American Bell Telephone Company: precisely to whom did you send it?

Ans. William C. Tompkins.

Int. 69. Do you know whether he is now in this city, or in the State?

Ans. I do not. I understand that he is in Pennsylvania.

Int. 70. You have mentioned two telephone lines which you ascertained to have been run from the defendant company's office, 171 Broadway, namely, one to S. E. Hibbard & Son in Fourteenth Street, and another to Pride, Freleigh & Kyle, corner of Church and Dey Streets: are these all the telephone lines which you ascertained were run from the defendant company's office?

Ans. No. I saw a set in the office of Mr. Bartlett, No. 2 Wall Street, said to be the vice-president of the Eastern Overland Telephone Company.

Int. 71. When was this, and what kind of telephone instruments did you see there at No. 2 Wall Street?

Ans. It was between the 26th and 29th of May, 1883. They were in appearance the same as others of the Baxter patents that I had seen. I only saw the outside of them, but they were connected up for use.

Int. 72. You have stated that a pamphlet like the Overland Telephone Company pamphlet was sent to you: did you ever have any other copy containing the same printed matter, and if with any additions, state what?

Ans. I had one handed to me by Mr. E. W. Smith, referred to in my affidavit, with the New Jersey advertisement printed on the back of it. It was on the fourth day of October, 1883.

Int. 7[illegible] What do you mean by the New Jersey advertisement, and who[illegible] as the Mr. Smith referred to?

Ans. I mean the advertisement of the Overland Telephone Company [illegible] New Jersey. E. W. Smith was the superintendent of that compa[illegible]y.

Int. 74. In your answer to Int. 20 you mentioned a conversation with Dr. Beckwith during your visit to the defendant company's office about the last of March or first of April, 1883: are you now able to locate the time of that conversation any more definitely?

Ans. Yes. I made a report of my visit, dated March 30 by my memoranda. It was close on to that date; it could not have been after that.

Int. 75. How extensive an acquaintance have you had with the use of telephones in this country?

Ans. I was instrumental in getting up the first Bell Telephone Exchange in New York, and have been intimately connected with the business ever since that date, and consider myself familiar with the details of the business in its various stages up to the present day. I have visited the various exchanges in different cities in New York State, New Jersey and Pennsylvania, and am tolerably well acquainted with the workings of those.

At one time I was superintendent of the Long Island district of the Metropolitan Telephone and Telegraph Company.

Int. 76. What is the usual mode of serving the community with telephones?

Ans. By means of the district-exchange systems, and by means of private lines running between two or more definite points.

Int. 77. Explain briefly the telephone exchange system and its general method of working.

Ans. The district-exchange system is composed of a number of subscribers having lines centring in a common central office, by means of which the subscriber may, on call, be put in private speaking communication with any member of the exchange,— in some places, many thousands.

Int. 78. How extensive is the telephone exchange system of the Metropolitan Telephone and Telegraph Company, which is one of the complainants in this case?

[*Defendants' counsel objects to this line of examination as entirely immaterial and irrelevant, having nothing to do with any issue in this case.*]

Ans. It covers the district of Manhattan Island, New York City, and numbers upwards of four thousand subscribers to-day.

It is connected by trunk lines with adjacent cities and cities on Long Island; with Jersey City, Newark, Paterson and suburban cities in New Jersey; with cities suburban to New York, in We[illegible]t

Chester County, running out to Sing Sing, and cities on the Hudson River, taking in a radius of thirty-three miles.

I should say approximately that eight thousand subscribers are thus brought into communication with each other.

Int. 79. What telephone instruments are in use in this exchange system, and in all other telephone exchanges or private lines known to you, other than the few instruments which you have ascertained to be used by the defendant company or by its procurement?

Ans. I don't know of any other than the Bell Telephone, except a few sporadic cases of individual manufacture which have been proceeded against as infringers by the Bell Company.

Int. 80. What instruments does such Bell telephone include?

Ans. The magneto-telephone receiver and the microphone or Blake transmitter principally, known as the carbon transmitter.

Int. 81. To whom do these Bell telephones belong, and how are they furnished for use?

Ans. They belong to the American Bell Telephone Company of Boston, and are leased and licensed to various exchanges throughout the country for operation.

Int. 82. What capacity has the Metropolitan Telephone and Telegraph Company for serving the entire community within which its telephone exchange system is operated?

Ans. In my experience they have been very ample for all applicants for service. Their pole lines and fixtures substantially cover the city of New York. They have nine central office stations, situated in different parts of the city, at the largest business centres from Harlem to the Battery, intercommunicating by means of trunk lines.

Int. 83. What apparatus and plant are needed for a telephone exchange such as that of the Metropolitan Telephone and Telegraph Company?

Ans. In each individual subscriber's office there will be needed a set of telephones, transmitter and receiver, signalling apparatus with battery and switches, lines running thence to the central office, poles and fixtures to support the wires and cables; at the central station, annunciator cases, operating tables, switch boards, batteries, jacks, keys, plugs, etc., etc., according to the system used. In large cities

like New York, where many central stations are needed, and the subscribers are greatly scattered over the city, large numbers of trunk wires or spare wires are needed. In this case the trunk wires are necessary to put a subscriber to one central station in communication with a subscriber whose lines terminate in another central station.

Int. 84. What is the relative cost of the mere telephone instruments, the transmitters and the receivers, as compared with the cost of establishing such a telephone exchange system as that of the Metropolitan Telephone and Telegraph Company?

Ans. The cost, comparatively speaking, is trifling.

Int. 85. To what extent has the Metropolitan Telephone and Telegraph Company established private lines as contradistinguished from lines centring in a telephone exchange?

Ans. There are about six hundred and over, I suppose, private-line subscribers in New York.

Int. 86. Has the number of miles of wire used by the Metropolitan Telephone and Telegraph Company for serving its subscribers been estimated, and if so, what is the aggregate?

Ans. I estimate it on a general average to be fully 4,500 miles. It is over that, in my opinion.

Int. 87. What has been the history of the establishment of the telephone exchange system in New York by the licensees of the American Bell Telephone Company and its predecessors, in respect to the employment of different kinds of apparatus, and the continuance or discontinuance of the same? And what has been the result as regards the expense of establishing a telephone exchange system adequate to the wants of the community?

Ans. In my experience we have changed our system four or more times throughout, exclusive of the telephone instruments themselves. We commenced with the Holmes system of annunciator drops and plugs on one case; then to the Crostrip switch board, plugs without cords; then the operating table system; then the auxiliary drop-case system appended to the same, which we have now. The change made in these different systems was followed in the method of operating in the subscribers' offices. Several differ-

ent styles of battery bells were used and discarded. Magneto bells were substituted. Several different styles of those were taken up and discarded to the improved bell of to-day. With each of these changes pretty much all of the apparatus belonging to the previous style was useless to them, the improvements taking their place. The methods of carrying the lines through the streets were found not to be adequate to a large business. The storm of 1881 showed them that, although these fixtures were heavy enough to carry the weight of wire and more, it was not calculated for such a sleet storm as happened in that year. This necessitated about a complete reconstruction of the line system. Old methods of entering the wires into offices by means of the cupola method in some instances have been discarded, and cabling been substituted. The changing of the wires from one system to another in some cases meant a destruction of the wire entirely; that is to say, being rusted, it could not be restrung. And as to the cost of taking down those wires where they could be saved, I estimate it at about equal to the destruction of the wire that would be reclaimed.

It has been estimated that at least $100,000 worth of property has been discarded; not because inoperative, but because impracticable for the exigencies of the business. And my experience would go to prove the same.

Int. 88. What would be the effect of establishing a rival telephone exchange within the same precincts as the telephone exchange now established, both as respects the service of the community, and the cost to the subscriber?

Ans. We had one rival exchange in New York, in the Gold and Stock Telegraph Company. The result of that was that about one half of the subscribers were obliged to duplicate the instruments by the Bell Company's instruments, in order to get the communication they were after, the same being in the rival exchange. This increased their cost proportionately. As to the service, it was not so good in either exchange, because of the multiplicity of wires, and the disregard for system in running them. Chiefly, the trouble came from crossed wires.

Int. 89. Explain a little more particularly why, in the case of two rival exchanges, a subscriber who wished to have communication

with any other subscriber to either of the exchanges would have to duplicate his telephone instruments.

Ans. In case a subscriber with the established exchange wished to communicate with a subscriber in the foreign exchange, and that subscriber was not also a subscriber with the established exchange, it would be impossible for him to do so, there being no communication between the two companies, unless he subscribed to that other exchange. This of course would increase his expense.

Int. 90. You have mentioned the rival exchange of the Gold and Stock Telegraph Company: how long did that continue, and what became of it, as far as you personally know?

Ans. I believe their exchange was established in '78, and absorbed in the Metropolitan Telephone and Telegraph Company, May 1, 1880.

DECEMBER 20, 1883.

Cross Examination resumed.

Cross-Int. 91. You think the interests of the public using telephones would be best promoted by having the entire business exclusively in the hands of one company rather than having it open to competition, as has been, perhaps erroneously, thought better in other branches of business, do you?

Ans. Well, in the subject that we had under discussion, the district-exchange system, I think it could be furnished cheaper by one company than by several. In that respect, I think the public would be better served by one company than more than one.

Cross-Int. 92. Do you think the interests of the public would be better served by having one company alone able to offer them the privileges you have spoken of, rather than two or more companies offering them equal privileges?

Ans. No. If it were possible for two or more companies to offer equal privileges, I think it would be better served by having them; but in the district-exchange system I think it hardly probable that they could do so.

Cross-Int. 93. I understand it to be your opinion, as a business man having some knowledge of telephones and telephone exchanges, that, with the existing system of telephone exchanges used by the Bell Company, it would be a disadvantage, rather than not, to the

public to have another exchange established by a rival company, even though it offered and was really able to furnish equal facilities with those now enjoyed by the Bell subscribers, to such people as might see fit to come into the exchange, and even though the rate of charge therefor might be considerably less than that now asked by the Bell Company: am I right?

Ans. I consider that question answered in the other answer. I said no, and I say *no* to this.

Cross-Int. 94. You said in your examination in chief that the cost of the wires and their erection and maintenance were very much greater than the cost of the telephone instruments: can you give me roughly the *data* upon which you base that conclusion?

Ans. Yes; the telephone instruments mentioned ought not to cost very much, being simple of construction; and I think any instrument maker would be willing to make them for $5 apiece, which is a very small proportion of the cost of running the line alone in ordinary cases.

Cross-Int. 95. The rate of charge for these telephones increases in a certain ratio, doesn't it, as the distance is greater over which the wire has to run?

Ans. Yes.

Cross-Int. 96. What is about the average cost of maintenance per mile of a line of wire?

Ans. Simply maintenance, I should be willing to maintain it in New York City for about $100 a year.

Cross-Int. 97. What does it cost the Metropolitan Company to maintain their wires per mile?

Ans. I do not know. According to different circumstances, it may cost more or less.

Cross-Int. 98. Then I understand that you are absolutely ignorant of what it costs the Metropolitan Company to maintain a mile of wire.

Ans. Yes, sir.

Cross-Int. 99. And yet you tesify that the cost of maintaining the wire is vastly greater than the cost and maintenance of the machines in New York City.

Ans. Yes, sir.

Cross-Int. 100. Do you know what the elements of the expense and construction account, aside from wages, etc., of the Metropolitan Company of New York are?

Ans. Yes. Placing of instruments in the office, and the construction of poles and fixtures to carry the wire, the running of the wire, construction of central offices with all its apparatus, rent, and wear and tear of plant, the incidental trouble of cross lines, and the falling down and reconstruction of the same, and various details I cannot of course go into.

Cross-Int. 101. Do you know what the annual charge to a subscriber is where he is say a mile off from the exchange in New York?

Ans. One hundred and fifty dollars *per annum*. And any distance inside of a mile the same.

Cross-Int. 102. Are there more subscribers to the exchange in Philadelphia than there are in New York?

Ans. There are more in New York.

Cross-Int. 103. As a general rule, is the average expense per subscriber greater or less where there is a larger number of subscribers than where there is a smaller?

Ans. Well, to a certain limit, the increase of numbers would not affect the average, but after that it would be greater, in this way: the multiplicity of wires would cause more contingent trouble from cross lines, etc., and difficulty in getting places for attachment, and the enormous increase of business going over the wires from the increased subscription list.

Cross-Int. 104. About where is the point where it would cost more per subscriber by the addition of members to the exchange?

Ans. Say five hundred centred in one central office.

Cross-Int. 105. After that it is a disadvantage to the company to increase the number of its subscribers, is it?

Ans. To a certain extent. That is to say, the profits will not be so large, and there would be a time when they would have to increase their rental.

Cross-Int. 106. Do you think the telephone system could be

worked to a profit in New York at a less charge than $150 a subscriber?

Ans. I have not figured upon that. I would not like to venture an opinion.

Cross-Int. 107. If it were a fact that, with an exchange somewhat though not very largely smaller in number, the cost to subscribers was between one half and three fourths as much as in New York, and there was still a profit in the business, you would infer that the rate in New York might be reduced very considerably below $150, and there still be a profit, would you not?

Ans. I can't see what that has to do with New York. If you will say in New York, I will tell you. In country towns the expense of maintaining a wire is merely nominal as compared with New York City.

Cross-Int. 108. Will you be kind enough to mention to me a country town in the United States that has an exchange only slightly smaller than that in New York? I would like to know the place; I want to go and see it.

Ans. What I had reference to was the exchange which is established in Brooklyn, where, though Brooklyn is not a country town, it takes to itself the features of a country town in respect to telegraph wires, there being comparatively few other wires than the telephone wires there, and it having a considerable exchange of 1,000 and perhaps 1,500 subscribers; and the cost of subscription there is proportionately less, — from $5.00 to $7.50 per month for a mile distance of wire, I believe.

Cross-Int. 109. This cost of maintenance of wire, and the difference in the cost of maintenance of wires in one place from that of another, will be materially reduced as soon as the underground system is generally adopted?

Ans. I should say so, materially.

Cross-Int. 110. I understand that you have already to a certain extent adopted an underground system of carrying your wires.

Ans. Whereas I did not say so, we have experimented in New York about it. The result I do not know.

[*Counsel for complainants states that he has this morning made inquiries at the electrical department of the American Bell Telephone*

Company, where Mr. Wm. C. Tompkins has his office, and has ascertained that Mr. Tompkins has been out of the State for several days, and has not yet returned. Counsel for complainants further states that he believes the sketch made by this witness, which has been called for, is, if in existence at all, still in the possession of Mr. Tompkins, and inaccessible until his return. Counsel for complainants also states that he has no objection to the production of the sketch, if it can be found.]

Cross-Int. 111. You know Mr. Tompkins, don't you, quite well?

Ans. Yes.

Cross-Int. 112. Where did you see him last?

Ans. I think in my office, 144 Greenwich Street, New York.

Cross-Int. 113. Do you know whether he was in the employ of the Bell Telephone Company at that time?

Ans. I believe he was. I never knew him in any other capacity. I believe him to still be in their employ.

Cross-Int. 114. How do you know that Pride, Freleigh & Kyle were instrument makers for the defendants?

Ans. Well, I was told so either by them or else by some one in the Overland Telephone Company's office.

Cross-Int. 115. You won't undertake to state positively that any one in the Overland Telephone Company's office told you that Pride, Freleigh & Kyle were their instrument makers, will you?

Ans. I answered the question to the best of my knowledge above, positively.

Cross-Int. 116. [*Question repeated.*]

Ans. No, I do not.

Cross-Int. 117. What was the date when you visited No. 23 Dey Street first on this matter?

Ans. Somewhere around the 15th of March, '83. That is as near as I can get at it. Memoranda would probably refresh my memory closely to it.

Cross-Int. 118. Was it before or after you had compared your copy of the rough draft of the Baxter specification with the Baxter specification itself?

Ans. Before that time.

Cross-Int. 119. Was the receiver which you took apart and ex-

amined, as you have spoken of, on the occasion of your visit to Pride, Freleigh & Kyle, in use at the time?

Ans. No, sir, it was not.

Cross-Int. 120. How do you know that it belonged to the defendant company?

Ans. I don't know.

Direct Examination resumed.

Int. 121. When did you first see the printed specifications and drawings of the Baxter patents published by the Patent Office, to the best of your recollection?

Ans. I cannot place the date at all.

Int. 122. Those Baxter patents were really issued May 8, 1883: with this information do you wish to correct your answer to Cross-Int. 51, which states that you first read the Baxter specifications after the issue of the Baxter patents, somewhere about the latter part of February or first of March?

[*Counsel for defendants objects to this question as most grossly improper and leading, and gives notice that he will move to strike out both question and answer from the record.*]

Ans. I wish to state right here that the first I ever read of the printed specifications was not over three months ago. The specifications that I referred to in the answer spoken of were manuscript, in February and March. I think I so stated. The part of the question that refers to after or before the issue of the patents, I did not understand until this present moment.

[*Counsel for defendants declines to further cross examine this witness on the question of dates, after the question last put by complainants' counsel.*]

DANIEL M. ADEE.

Attest: CHAS. H. SWAN, *Special Examiner.*

DEPOSITION OF CHARLES R. CROSS.

Direct Examination by GEORGE L. ROBERTS, Esq., *of Counsel for Complainants.*

BOSTON, Dec. 20, 1883.

Int. 1. State your name, age, residence, and occupation.

Ans. Charles R. Cross; I am thirty-five years old; I live in Boston; and am Thayer Professor of Physics in the Massachusetts Institute of Technology.

Int. 2. State how long and to what extent you have been engaged in the study of the physical sciences; and to what extent, if at all, you have been accustomed to make experiments in the several branches of physics, especially those relating to electricity and acoustics.

Ans. I have been an instructor at the Institute of Technology during the past thirteen years, and during that time I have been constantly engaged in the study of various branches of physics. During the past eleven years I have especially investigated the subjects of acoustics and certain branches of electricity. In the prosecution of my studies during this time I have constantly been engaged in the experimental study of the subjects mentioned, and have been practically familiar with all the apparatus ordinarily used by scientific men in the investigation of sound and electricity.

Int. 3. What attention have you given to the speaking telephone, and to its principles and mode of operation?

Ans. I have been familiar with the rise and development of the speaking telephone from its very beginning, having been in frequent communication with Prof. Bell ever since the winter of 1873–4. I am familiar with Mr. Bell's patents, have investigated with great care the theory upon which these patents are based, and am practically familiar with the construction and use of the various forms of instruments constructed in accordance with said patents. During the past five years I have conducted a very extensive series of experiments relating to the different branches of telephony, in the capacity of expert for the Bell Telephone Company.

Int. 4. State whether you have given attention to that form of telephonic transmitter which operates by varying the resistance of a circuit.

Ans. During the last five years I have given special attention to the theory and operation of variable-resistance battery transmitters. I have made a large series of original experiments and investigations upon the subject, more extensive than any that I have ever seen in print. I have carefully studied the distinctions which exist between variable-resistance battery transmitters and circuit-breakers, as well as the differences in the electrical and acoustic effects which they produce in the line wire and in the receiving telephone.

Int. 5. State whether or not you have testified as a witness in any cases in the courts of the United States, upon the principles of the invention embodied in patents, and in machines or apparatus.

Ans. I have done so frequently.

Int. 6. You say you have been familiar with Mr. Bell's patents. State whether or not among these patents are those which have been introduced in evidence in this case marked "Exhibit Bell Patent No. 174,465," and "Exhibit Bell Patent No. 186,787."

Ans. The patents No. 174,465 and No. 186,787 are among those which I have had frequent occasion to examine.

Int. 7. Referring to the patent No. 174,465, will you explain the mode of operation of the apparatus referred to in the 5th claim of the patent, explaining, as far as may be necessary, the character of sounds, their action upon the apparatus, and the manner in which the apparatus operates to produce the results which are ascribed to it in the patent?

Ans. The sensation of sound is produced by the action upon the ear of the vibrating particles of air which are set into a vibratory, or to-and-fro motion by the vibrations of the sounding body. The primary impulse given by the sounding body to those particles of air immediately in contact with it is gradually transmitted from particle to particle, in consequence of the elasticity of the air or other medium through which the sound passes. In consequence of the mode of action of the elasticity of the air, the motion originally communicated to the particles of air in contact with the sounding body is not transferred instantaneously to all the other particles;

but in consequence of their *inertia*, as the sounding body vibrates to and fro, a similar movement is impressed upon one after the other of the particles surrounding it. This to-and-fro motion of the vibrating body generates a similar minute to-and-fro motion of the air particles, so that they are alternately crowded more closely together, and separated more widely from each other, thus producing alternate condensations and rarefactions in the air. It is to these alternate condensations and rarefactions that the term "sound wave" is given. It will be observed that each particle vibrates to and fro in a straight line in the direction in which the wave motion is propagated. If we consider that the vibration of the air particles is produced immediately by the vibration of the sounding body, we see that the motions of the air particles must be a perfect copy of the motions of the particles of the vibrating body. Such vibrations may differ in three separate ways, viz., in the extent of the path of the vibrating particle, in the frequency of its vibration, and in the character of its vibration. It is evident, in the first place, that the vibrating particle may, in its to-and-fro motion, traverse a longer or shorter path; in the second place, it may traverse this path a greater or less number of times in each second, that is, its rate of vibration may differ; in the third place, while traversing its path it may move according to different laws of acceleration or retardation of its velocity: for example, its acceleration during a part of its course may be and in some cases is constant, or the rate of acceleration may constantly change, and the law of its change may vary in different ways. To the changes in the motion thus caused, what I have called the peculiar character of the vibration is due. If we consider these three kinds of variation in their effect upon the senses, we find that variations in the extent of the path or amplitude of vibration of the particle determine, other things being the same, the loudness of the sound; the variations in the frequency of vibration determine the pitch of the sound; and variations in the character of the vibration determine what is known as the quality, or *timbre*, of the sound.

In the statements which I have just made I have spoken of the motion of a single particle; but it is evident, from the mode of transmission of sound, that all of the particles of the air through

which the sound is conveyed partake of the various characteristics of vibration which I have discussed.

I have used the term "quality or *timbre*"; quality is that peculiarity of a sound by which, independently of its pitch or loudness, we are enabled to determine the instrument by which the sound is produced; thus, for example, the note of a violin differs from the note of a flute in quality, even though the two are the same in pitch and loudness.

It is well known to scientific men that these differences in quality, which, as I have said, are due to differences in the character of the motions of the vibrating particle, are produced acoustically by the combination of a number of separate or partial tones, which can be shown to be produced when a particle is in vibration; and which partial tones differ in number, in pitch and in intensity or loudness, in accordance with differences in the character of the motion of the vibrating air particles.

The lowest of these partial tones is called the "fundamental," the other and higher notes "overtones." Hence it is evident that the quality of a sound depends upon the relative pitch, intensity and number of partial tones present. In a very few exceptional cases only the fundamental is present, and what is called a simple sound is produced. In general, the pitch of a note is determined by the fundamental, the overtones determining the quality.

"When we speak of the pitch of the note produced by a string or an organ pipe, we mean in fact the pitch of the gravest simple tone in the combination. This particular component is in general louder than any of the others, and is that on which attention is fixed. The others become associated with it by habit, and seem only to modify its character without destroying the unity of its pitch."

Donkin on Acoustics, p. 11.

These facts, constituting what is known as Helmholtz's Theory of Quality, were first discovered by the physicist whose name the theory bears. The human voice owes its peculiar quality to the presence of great numbers of these partial tones; and very slight changes in the partial tones will produce very considerable changes in the voice.

"Human speech employs these very qualitative varieties of tone in order to distinguish different letters."

. . . . . .

"On inquiring to what external physical difference in the waves of sound the different qualities of tone correspond, we must remember that the amplitude of the vibration determines the force or loudness, and the period of vibration the pitch. Quality of tone can therefore depend upon neither of these. The only possible hypothesis, therefore, is that the quality of tone should depend upon the manner in which the motion is performed within the period of each single vibration."

. . . . . .

"Every different quality of tone requires a different form of vibration." (*Helmholtz, Tonempfindungen*, Ellis's Translation, pp. 28, 32.)

From what I have said thus far, it will be seen that, in order to reproduce articulate speech, we must be able to reproduce, in the air, vibrations which shall possess these three characteristics of pitch, intensity and quality; and which shall, moreover, possess those same characteristics of pitch, intensity and quality, — that is, of rate of vibration, amplitude of vibration, and character of vibration, — which are possessed by the vibrating particles which are set in vibration directly by the organs of speech. If we can determine the speed and direction of motion of an air particle at each instant, and hence, also, the extent of its path, we can evidently impress upon it all three of the characteristics that I have mentioned; and hence can produce any desired sound at will.

In Mr. Bell's patent No. 174,465 a method is described by which the motions which are produced in the air at one place, the transmitting station, can be reproduced by an electrical method of intercommunication at the receiving station. By means of his invention he is able, by the use of certain electrical apparatus, to impress upon the particles of air at a distant place, the receiving station, motions substantially identical with those which are immediately impressed by the voice upon the particles of air at the transmitting station.

According to the specification, he effects this result by the use of the transmitter, which takes up from the air at the transmitting station the motions which are impressed upon it by the voice of the speaker, and the vibrating portion of which transmitter moves in sub-

stantial accordance with the movements of the air particles themselves. This transmitter, being connected with a line wire joining the two stations between which speech is to be transmitted, is enabled, by its electrical connection with that wire, to produce in it electrical variations which correspond to and are similar in form to the motions of the movable part of the transmitter, and hence to the motions of the air particles which have actuated the movable part of the transmitter. These electrical variations, in their turn, set in motion a movable part of a receiving instrument with which the line wire is connected, and in their turn produce in this movable part of the receiver vibrations corresponding to and similar in form to those electrical vibrations by which they are produced, and hence to the motions of the air particles at the transmitting station. The movable part of the receiving instrument, thus vibrating, impresses upon the air at the receiving station vibrations similar in form and corresponding to its own motions.

The motions thus produced in the air particles at the receiving station are therefore evidently similar in form, and correspondent to the original vibrations impressed upon the air at the transmitting station by the voice of the speaker at that station. This being the case, it is evident, from what I have said, that the sound uttered by the speaker at the transmitting station will be reproduced at the receiving station.

It appears from these facts that Mr. Bell's apparatus consists essentially of a transmitter adapted to take up the vibrations of the air at the transmitting station; a line wire connecting the transmitting with the receiving station, together with a battery or some other form of electrical apparatus, which is capable of furnishing a supply of electricity; which line wire shall serve to transmit the electrical variations produced by the transmitter from one station to the other; and a receiver which, actuated by the electrical variations thus transmitted by the line wire, shall be caused to reproduce the motions of the transmitter and of the air particles by which that transmitter is actuated. It is true that the receiving instrument may not always reproduce the vibrations of the air particles at the transmitting station in every minute detail, but the instrument is a speaking telephone only so far as it is adapted to reproduce those

motions with substantial fidelity; and its practical construction and operation must be such that these vibrations shall be substantially reproduced.

It is evident that when the transmitter is in operation, variations in the electrical current may take place in three ways,— there may be a variation in either the direction of the current, the rate or violence of change of the current, and the frequency of change of the current; and from these three kinds of variations similar variations in the direction, rate and frequency of change of the motion of the movable part of the receiver will result. And hence, from these different electrical variations, differences in the quality, intensity and pitch of the sound produced by the receiving instrument will follow. Therefore, to reproduce articulate speech or any other sound in all its characteristics of pitch, intensity and quality, it is necessary that the movable portion of the receiving instrument shall be constantly under the guidance of and controlled by the movable portion of the transmitting instrument; and in case this constant control is not exercised, and in precisely that degree in which it ceases to be exercised, the instrument becomes incapable of transmitting articulate speech.

No form of transmitter which operates by making and breaking an electrical circuit can possibly transmit articulate speech or any other sound in its different characteristics of pitch, intensity and quality, for the reason that the constant control of which I have spoken is not exercised in such an instrument. With any circuit-breaking instrument, the loudness and quality of the sound produced at the receiving station are dependent solely upon the physical construction and action of the receiving instrument itself, and of the battery or other source of electricity by which the transmitter is acted upon. The intensity and quality of the sound produced at the receiving station are therefore, with such an instrument, entirely independent of the intensity and quality of the original sound produced at the transmitting station. It is for this reason that an instrument of this class, such as, for example, the well-known Reis instrument, operating in the manner described, is incapable of transmitting either intensity or quality; and hence is incapable of transmitting articulate speech.

As will be seen from what I have already said, the Reis transmitter, or any other transmitter which operates by making and breaking the circuit, is capable of transmitting pitch, and pitch only.

The essential difference between the electrical changes produced by the Reis transmitter and the changes produced by the apparatus Fig. 7 of the Bell patent No. 174,465, when spoken to, is that the action of the Reis apparatus serves to break up into successive and disjunctive fragments a current of substantially uniform strength. This is a merely intermittent current. The frequency of its intermittences is the same as the frequency of the air vibrations which give rise to what is known as the pitch of the sound acting upo the transmitter. The apparatus Fig. 7 of Mr. Bell's patent, on th other hand, produces, when spoken to, a series of electrical chang which in their character correspond to and substantially copy t changes which take place in the air performing the sonorous vib tions to be transmitted. The apparatus of Reis was intended produce mere intermittences, the frequency of which correspon to the pitch of the sound transmitted. The apparatus of Bell, the other hand, was not intended to produce intermittences; nor its operation due to their production. The declared purpose of invention is to produce electrical variations, which, in their fo copy the vibrations of the air. This is the distinction between mode of operation of one apparatus and the mode of operation of the other. It is the employment of the electrical changes due to and constituting one mode of operation, as distinguished from the other, that is insisted upon by Mr. Bell in his patent and specified in his claim. It is because Mr. Reis employed the one mode o operation that his apparatus is not a speaking telephone, and it because Mr. Bell employed the other that his apparatus is.

There is also another reason which prevents a Reis transmitte or other circuit-breaking instrument, from transmitting articulate speech; this is the effect of the interruptions of the current, in pro ducing a loud and disagreeable noise in the receiver, which, o itself, would be sufficient to overpower and obliterate those fin shades of variation upon which differences in quality depend.

In fact this noise is so marked that an ordinary battery transmitter can be used as a telephonic call by so operating it as to cause it

to actually make and break the electrical circuit. Under these circumstances, the noise which proceeds from the receiving instrument, which, when the transmitter is used in a normal and proper manner, can be heard only by one close to the instrument, is capable of being heard throughout a large room.

Int. 8. You have described the operation of a speaking telephone apparatus when transmitting speech as set forth in the specification of Mr. Bell's patent No. 174,465: will you now state briefly what is the function and importance of the similarity between the vibrations of the air accompanying sounds uttered into the transmitter, and the electrical undulations which are caused in the apparatus while transmitting speech, as particularly referred to in the fifth claim of Mr. Bell's said patent, which is as follows: —

"5. The method of and apparatus for transmitting vocal or other sounds telegraphically, as herein described, by causing electrical undulations similar in form to the vibrations of the air accompanying the said vocal or other sounds, substantially as set forth"?

Ans. It is because of this similarity that speech is transmitted. In a perfect instrument the motions of the receiver are both the effect and a copy of these electrical variations. Since these electrical variations are a copy of the motions of the transmitter, it follows that the motions of the receiver are a copy of those of the transmitter; if substantially this action takes place, speech is transmitted, otherwise speech is not transmitted.

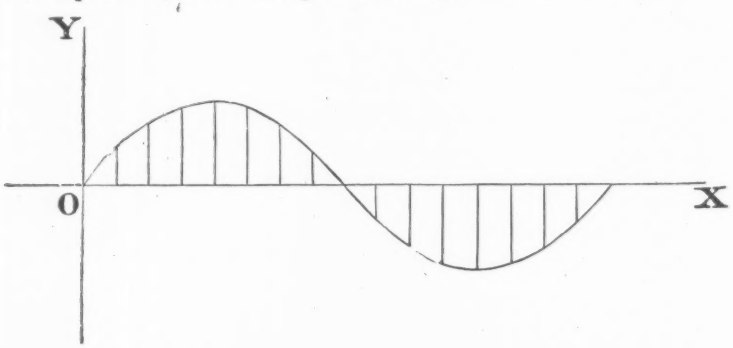
Int. 9. You speak of the sound waves, and explain the mode in which they are produced: do you understand that the actual existence of these sound waves has been demonstrated, or is accepted as a fact by scientific men?

Ans. The existence of such sound waves has been accepted as a fact by scientific men for several hundred years. Within a few years past they have been visibly shown to exist, by a method which demonstrates the existence of alternate condensations and rarefactions to the eye.

Int. 10. Has any method of representing such waves been adopted; and if so, what is it?

Ans. It is customary among physicists to represent the motions

of the particles of a sound wave, and also the variations in condensation and rarefaction at different points in a sound wave, by a graphical method. I can best illustrate this by reference to a diagram which I produce, to be incorporated in my answer.



The curve in the diaphragm is what is called a sinusoidal curve, such as corresponds to the sound waves produced by a simple sound, consisting of a single note without overtones. (Such a sound can be produced by a tuning fork, mounted on a resonant case, and bowed in a manner suitable for this purpose.) O X is divided into a number of equal spaces, to represent equal periods of time. The length of these spaces is purely arbitrary. The distances from O to the beginning of any one of these divisions are called *abscissas*. From each of these points on O X, representing successive intervals of time, lines are drawn parallel to O Y, and proportional in their relative lengths to the distances of the particle from the point of rest at the successive periods of time. In the case of the particle pursuing a simple vibration, these magnitudes will increase to a maximum, which will be attained at the instant when it reaches the extremity of its path; they will then diminish, as it comes back to the starting point; and as it passes beyond it, moving in the other direction, they will be indicated by distances measured off below the line O X. Joining then the extremities of the perpendicular lines, we obtain a broken line somewhat resembling a curve; and if we put the perpendicular lines close enough together, the broken line joining their extremities becomes a curve. This curve is determined by the length of two sets of lines or distances, — the *abscissas* measured on O X, and

the *ordinates* measured parallel to O Y. In the case stated, the starting point is assumed to be in the middle of the path (*e. g.*, the position of a pendulum when at rest), and the motion is measured in both directions from it; *i. e.*, the curve is on both sides of the line, and part of the ordinates have one direction, part the other. But the point from which the measurements are taken is purely arbitrary; and the line O X, which represents this point, might be placed lower down and tangent to the lowest part of the curve. In that case the curve would not change its character, but the ordinates would all be measured in one direction and on one side of O X. Algebraically expressed, they would all be + quantities, instead of being alternately + and — quantities in the two branches of the curve; only, the + quantities would be greater than shown in the diagram. In the case indicated by the diagram, we should consider that an increase in the length of the ordinates, in passing from one to the next, signified motion in one direction, and a decrease signified motion in the other direction. In this method of representation one set of lines, measured along O X, corresponds to the period in which the movement is executed, or its frequency; and the other, measured along O Y, to the amplitude or extent, and also to the direction of the motion; and these measurements express frequency, amplitude and direction. The same curve will represent the extent of rarefaction and of condensation of the air produced by the movement of the particles, and also, when correctly interpreted, the motion and the varying velocity of the particles.

It is from this habit of graphical expression that a vibration is commonly spoken of among physicists as having "form"; form of vibration is a phrase used to signify the "character" of a vibration, as I have explained it.

It must be remembered that this curve does not represent the path of the moving particle: that always moves to and fro in a straight line. This curve is merely a convenient form of expressing to the eye the character and variation of the motion.

I quote again from the work of Helmholtz: —

"To render the law of such motions more comprehensible to the eye than is possible by lengthy verbal descriptions, mathematicians and physicists are in the habit of applying a graphical method,

which must be frequently employed in this work, and should therefore be well understood." (p. 29.)

The writer then describes the method of drawing acoustic curves, and continues: —

"Physicists, then, having in their mind such curvilinear forms, representing the law of the motion of sounding bodies, speak briefly of the *form of vibration* of a sounding body, and assert that *the quality of tone depends on the form of vibration*." (p. 32.)

"I have by no means unfrequently found even physicists start on the false hypothesis that the vibrational form must exhibit little waves corresponding to the several audible upper partial tones." (p. 53.)

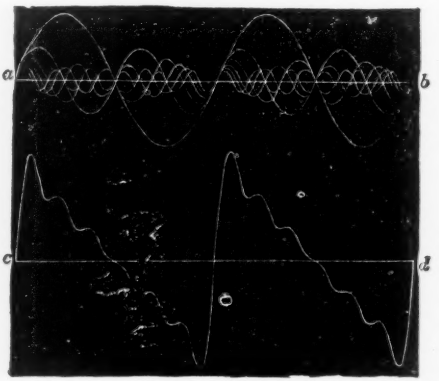
. . . . . .

"The reader must bear in mind that when we apply the term 'compound' to the vibrations produced by a single musical instrument, the 'composition' has no existence except for our auditory perceptions or for mathematical theory. In reality, the motion of the particles of the air is not at all compound; it is quite simple, flowing from a single source." (p. 189.)

. . . . . .

Int. 11. If you can produce from any scientific work a diagram representing the manner in which overtones are combined with a fundamental to give quality to sound different from that due to the fundamental alone, and representing the form given to the curve as the result of all the vibrations, will you do so, stating the source from which you derive it, and explaining, as far as you think necessary, the diagram?

Ans. The following diagram, taken from "Mayer on Sound," p. 153, represents the motion of a particle under the influence of sound waves: —



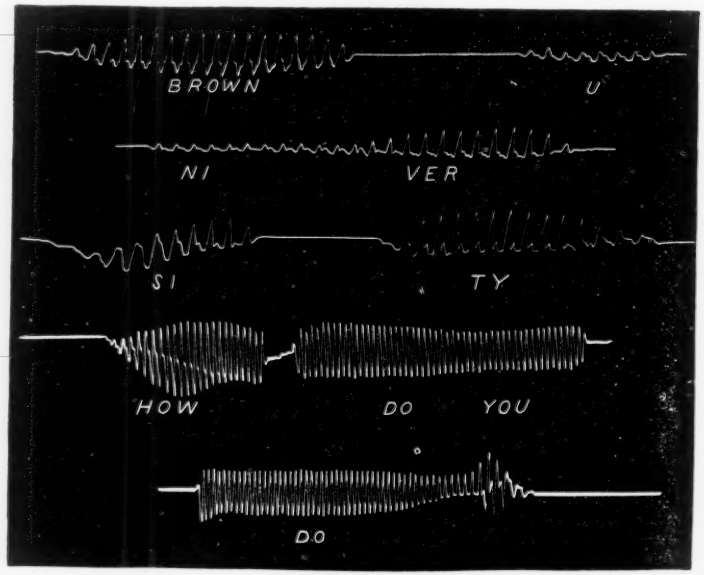
The curves at *a b* represent six sound waves of six simple sounds. When these are sounded together as fundamental and overtones, and with relative intensities corresponding to the amplitude of the curves, as drawn, so as to produce a sound having the quality due to this combination, the vibrational "form," as it is called, of the sound perceived by the ear is represented by the curve at *c d*. The set of vibrations which constitutes one complete vibration is shown twice between *c* and *d*. The entire "form" or character of this curve can be determined and controlled, as already stated, by determining or controlling for each point the length of the abscissa and of the ordinate for that point, or in other words, determining or controlling the elements of time or frequency, amplitude or intensity, and direction; but it is obvious that it will require very many measurements of abscissas and ordinates to determine or control the "form" of each complete set of vibrations.

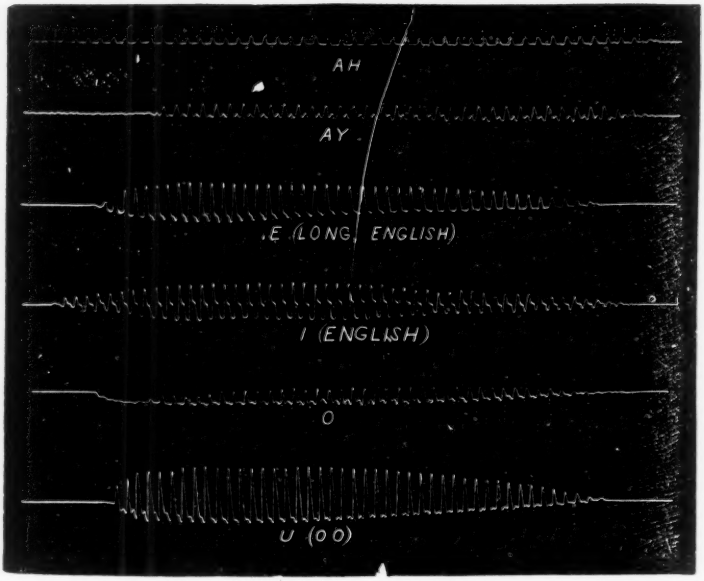
The curve representing one set of vibrations is about three inches long; and it is apparent, even to a casual observer, that by taking the ordinates as little as one eighth of an inch apart, we should miss the little twists which most strikingly represent to the eye the "quality" or the effect of the overtones in this vibrational form, and which are equally important to the "quality" of the sound as perceived by the ear; and, as in the articulate speech of a woman there are twenty-four thousand of these *complete* sets in a minute, it will be obvious that in order to reproduce this vibration the control must be exercised not merely twenty-four thousand times a minute, but really without any interruption or cessation whatever.

Int. 12. If observations have been made upon the curves produced by spoken words, and you can produce a diagram representing the results of such observations, will you do so, giving the authority from which they were made?

Ans. The minute changes which take place during articulation are well shown in a series of curves made by Prof. E. W. Blake, Jr., of Brown University, and described in *Silliman's Journal* for July, 1878. These curves were produced by reflecting a ray of light from a mirror, so attached to the plate of a speaking telephone that the vibrations of this plate were communicated to the mirror. The reflected ray is caused to act photographically upon a

sensitized plate of glass, the mirror at the same time being caused to vibrate by the action of the voice upon the telephone plate. On





rapidly moving the plate of glass in a direction at right angles to that in which the reflected ray was caused to vibrate by the vibrations of the mirror, a photographed representation of the complex vibrations of the mirror was produced. In Prof. Blake's figures the vibrations characteristic of different vowels, and the rapidly changing vibrations produced in the case of a spoken sentence are very beautifully shown. According to the statement made by Prof. Blake in the article referred to, the vibrations are magnified in the accompanying cuts one hundred and twelve times. Notwithstanding the accuracy of Prof. Blake's drawings, the mere thickness of the lines in the wood-cut is sufficient to obliterate many of the more delicate variations in those vibrations which characterize articulate speech.

Int. 13. Referring again to the first Bell patent (No. 174,465), to which your attention has been called, will you state what the moving parts are which you have referred to as being put in motion by sound waves, or by variations of current produced by sound waves?

Ans. In Fig. 7 the transmitter possesses a movable armature, *c*, one end of which is hinged, while the other is so attached to a membrane at *a* that when this membrane is set in vibration by the utterance of a sound into the cone, A, the armature shall be caused to take up the vibrations of the membrane. By the vibration of this armature, as it approaches nearer to or recedes from the pole of the electro-magnet *b*, in accordance with the well-known laws of magneto-electric induction, electrical undulations or waves are produced in and transmitted by the line wire *e*. The receiving instrument which is in electrical connection with the line wire possesses an electro-magnet *f*, whose magnetic strength varies in accordance with the electrical variations produced in the line wire in the manner described. In front of this electro magnet of the receiver, and opposite its pole, is a vibratory armature of inductive metal hinged at *k*, and connected at *i* with a membrane stretched over the larger end of the cone L, so that variations in the magnetic strength of the electro magnet *f*, produced by electrical variations in the line wire *e*, produce vibrations in the armature *h*, and consequently in the attached membrane, so that this attached membrane vibrates in correspondence with the motions of the membrane of the transmitting

instrument, and therefore in correspondence with the vibrations of a voice by which the membrane of the transmitter is actuated. I should have said that the vibrating armatures of both the transmitting and receiving instruments are of iron or other inductive metal; and I would also call attention to the fact that the hinged end of each of these vibratory armatures is in magnetic connection with that pole of the electro-magnet which is farthest from the vibrating part of the armature itself; this mode of connection serving to increase to a certain degree the magnetic strength of the apparatus.

Int. 14. Will you explain a little more in detail the function of the battery represented in Fig. 7 of the Bell patent of which you have been speaking, and the manner in which the undulations in the current are produced in the apparatus represented in that figure, and in what way the undulatory current acts in the receiving instrument to produce the proper results?

Ans. The magnets *b* and *f* in Fig. 7 are electro-magnets, having soft iron cores, which cores are magnetic only when a current of electricity is passing through the coils surrounding them. The object of the battery shown in Fig. 7 is simply to produce this current, which shall cause the cores to be kept magnetized. The armature *c* of the transmitter, which is of iron or other inductive metal, will, as it moves to and fro, alternately increase and diminish the magnetic strength of the magnet *b*. These variations of magnetic strength will correspond to the various changes in motion of the vibrating armature. In accordance with the well-known laws of magneto induction, as discovered by Faraday, every change in the magnetic strength of the core of the electro-magnet *b* will produce corresponding changes in the current of electricity which passes through the line wire *e*. These variations in the strength of the current will cause corresponding variations in the magnetic strength of the electro-magnet *f*, and these variations in the strength of the magnet will act immediately upon the vibratory armature at *h*. An increase of strength in the magnet *f* will cause the armature to approach to the magnet, while diminution of magnetic strength will allow the armature, under the influence of the tension of the membrane to which it is attached, to recede farther from the pole *f*. Hence, under

the influence of the varying magnetic strength of *f*, the vibratory armature at *h* will execute vibrations corresponding to these changes in magnetic strength, and therefore corresponding to the changes in the electric current in the line wire *e*, to the changes in the magnetic strength of the magnet *b*, and therefore corresponding to the variations in the motion of the vibratory armature at *c*, when moved by the vibrations of the membrane with which it is in contact. The membrane of the receiving instrument at *i* will therefore vibrate in correspondence with the membrane *a* of the transmitting instrument.

Int. 15. Do you find any mode suggested in the patent as an alternative one to that you have described, of producing the variations or undulations in the current between the transmitter and receiver; if so, will you quote from the specification the language which refers to such other mode?

Ans. It was well known to electricians long before the date of Mr. Bell's first patent that the strength of electrical current can be varied, either by increasing its electro-motive force or by diminishing the resistance of the circuit, in accordance with the well-known law of Ohm, $\text{Strength of Current} = \frac{\text{Electromotive force}}{\text{Resistance of Circuit}}$.

In the apparatus which I have described, Mr. Bell explains a mode of producing these electrical undulations by varying the electro-motive force of the current. He also clearly recognizes the possibility of producing such undulations by varying the resistance of the circuit. In his specification No. 174,465, I find the following: —

"Electrical undulations may also be caused by alternately increasing and diminishing the resistance of the circuit. . . . The internal resistance of a battery is diminished by bringing the voltaic elements nearer together, and increased by placing them farther apart. The reciprocal vibration of the elements of a battery, therefore, occasions an undulatory action in the voltaic current. The external resistance may also be varied. For instance, let mercury or some other liquid form part of a voltaic circuit; then the more deeply the conducting wire is immersed in the mercury or other liquid, the less resistance does the liquid offer to the passage of the current. Hence the vibration of the conducting wire in mercury or other liquid included in the circuit, occasions undulations in the current. The vertical vibrations of the elements of a battery in the liquid in which they are immersed produce an undulatory action in the current by alternately increasing and diminishing the power of the battery."

Int. 16. If electricians have been in the habit of stating the law to which you have referred, in algebraic terms, will you give the form of expression which has been used, explaining the symbols, and state how long that law has been known, and whether or not it is one which has been found of use in the practical application of electricity?

Ans. The law of Ohm is usually expressed by a formula $c=\frac{E}{R}$, in which C is the strength of the current; E the electro-motive force, that is, the force producing the current; and R the total resistance of the circuit. Ohm's law was, if I recollect rightly, first stated by him about the year 1830. For the last thirty years its importance has been fully recognized by physicists, and it has been applied by constructors of electrical apparatus in determining the dimensions and arrangement of the different parts of such apparatus.

Int. 17. State whether or not, in your judgment, the substitution of one of these ways of varying the current for the other, changes substantially the character of the described apparatus as an apparatus for transmitting sounds, or changes substantially the method by which sounds are transmitted or reproduced.

Ans. Speaking as a scientific man, I should say that it does not.

Int. 18. Have you examined and tested the instruments marked "Exhibit Defendants' Transmitter No. 1" and "Exhibit Defendants' Receiver," and have you also examined Patent Office copies of the United States patents No. 277,198 and No. 277,199, each dated May 8, 1883, and granted to the Overland Telephone Company as assignee of Myron L. Baxter; and do you understand the construction and mode of operation of the instruments therein respectively described? If so, will you compare Exhibit Defendants' Transmitter No. 1 with the instrument described and shown in the patent No. 277,198; and Exhibit Defendants' Receiver with the instrument described and shown in patent No. 277,199; and state how the things so compared agree or differ substantially in their construction and mode of operation?

Ans. I have examined and tested the exhibits referred to, and have examined the Patent Office copies of the Baxter patents, and understand the construction and mode of operation of the instruments therein described. The instrument described in the Baxter

patent No. 277,198 is therein designated "a transmitting telephone," and it is essentially the same in most of its details as the Exhibit Defendants' Transmitter No. 1 The chief differences which I notice are the following: 1st, the suspended bar C, instead of being hung as represented in the drawing, has the axis from which it is suspended attached to a flange at the upper end of the bar and projecting toward the front of the transmitter. The effect of this mode of mounting is to increase the pressure between the electrical contact pieces of the transmitter. 2d, the induction coil of the apparatus is not arranged as shown in the drawings of the patent No. 277,198, but forms a portion of the apparatus separate from the electro-magnet E, which is simply a straight bar electro-magnet, in substantially the position shown in Fig. 2 of the patent.

The Baxter patent No. 277,199 describes an instrument therein designated as a receiving telephone. The Exhibit Defendants' Receiver conforms substantially in its construction to Fig. 1 of the said patent, except that the iron coil, intermediate between the two copper coils, is made of an iron ribbon, as shown in Fig. 3, instead of iron wire, as shown in Fig. 1. I also find wound about the outside of the copper outer coil D^2 a long and ribbon-like tinfoil condenser, to which no allusion is made in the patent. These differences do not substantially change the mode of operation of the instruments compared.

Int. 19. Have you examined and tested Exhibit Defendants' Transmitter No. 2, and if so, how does it correspond with or differ from the instrument described and shown in the Baxter patent No. 277,198?

Ans. I have examined and tested this exhibit. It is constructed in substantial accordance with the figures of the Baxter patent No. 277,198. The particular differences which I notice are: 1st, that the magnet E and the induction coil are separate in the exhibit, instead of being combined as in Fig. 2 of the patent. 2d, a flexible metallic strip connects the suspended bar with the iron frame of the instrument, thereby insuring a good electrical connection of the suspended rod with one of the conducting wires. The carbon contact piece carried by the suspended bar in the Exhibit Defendants' Transmitter No. 2, is provided with a relatively longer adjusting screw than that shown in the drawings of the Baxter transmitter patent. In conse-

quence of the greater length of this screw, the suspended bar can be thrown farther out of the vertical and into an inclined position, and thus increase the pressure between the electrical contact pieces. These differences do not substantially change the mode of operation of the instruments compared.

Int. 20. For what purpose do you find the instruments, Exhibit Defendants' Transmitter No. 1, and Exhibit Defendants' Receiver, to be adapted; and what has been the result of your tests with them?

You may also answer the same questions in respect to Exhibit Defendants' Transmitter No. 2 when substituted for Exhibit Defendants' Transmitter No. 1.

Ans. I find that the instruments referred to, namely, Exhibit Defendants' Transmitter No. 1, and Exhibit Defendants' Receiver, are, from their construction and method of operation, adapted, when suitably connected with a battery, to transmit articulate speech. I have in fact so connected them, and transmitted articulate speech by means of them. The same is likewise true of Exhibit Defendants' Transmitter No. 2 when substituted for Exhibit Defendants' Transmitter No. 1.

Int. 21. State whether or not, in your judgment, when so connected and used for that purpose, they constitute an apparatus substantially like that described in the Bell patent of which you have been speaking, and referred to in the 5th claim, and which will operate in transmitting sound by substantially the same method; and whether or not, in your judgment, they embody, when so used, the invention described in said patent and referred to in said claim.

Ans. The apparatus to which I have referred in my last answer, Exhibit Defendants' Transmitter and Exhibit Defendants' Receiver, when connected and so operated as to transmit articulate speech, use the method invented by Mr. Bell, and described in his specification No. 174,465, for transmitting vocal or other sounds telegraphically, by causing electrical undulations similar in form to the vibrations of the air accompanying such sound. The instruments in question most certainly embody the invention which Mr. Bell describes in his specification referred to, and when used in the transmission of articulate speech, constitute an apparatus which is substantially that described by Prof. Bell.

Int. 22. In the operation of transmitting speech in the Baxter apparatus, what is the importance of causing the electrical undulations to be similar in form to the sound waves?

Ans. Precisely the importance which is indicated in my answer to Int. 8. Any departure from similarity impairs the character of the speech to the extent to which it occurs; and when that departure or any extraneous disturbance reaches a certain point, the sounds at the receiver cease to be intelligible as speech.

Int. 23. Will you compare these instruments when so connected and used, with Mr. Bell's apparatus, to which you have referred, pointing out the functions and mode of operation of the several parts; and if you find that these instruments differ specifically from the Bell apparatus, explain the nature of the differences, and give your judgment as to their affecting the substantial likeness of this apparatus to the Bell apparatus and its method of operation?

Ans. In Mr. Bell's patent No. 174,465, I find a transmitting instrument, a receiving instrument, a line wire connecting these, and a battery or other source of electricity. In the apparatus described, the transmitter possesses a movable part, which is capable of being set in vibration by the agency of the voice. This movable part is so arranged that it shall cause electrical variations in the current traversing the line wire. The receiver is so arranged that the variations of current, referred to, shall communicate motion to a movable part, which shall in its turn communicate motion to the air about it. As I have already shown at some length, the vibrations of this movable portion, when actuated by the sound waves produced by the voice, correspond to these in form, and by their action upon the receiving instrument cause it to vibrate in a similar manner, and hence produce corresponding vibrations in the air about the receiver. The function of the transmitter, it is evident, is simply to produce in the line wire electrical undulations similar in form to the vibrations of the air particles through whose agency they are produced. The function of the receiver is simply to translate, so to speak, the electrical undulations produced by the transmitting instrument and conveyed to the receiving instrument by the line wire, into vibrations of the air at the receiving instrument. Mr. Bell indicates that these electrical undulations may be produced either by varying the electro-

motive force of the current, or by varying the resistance of the circuit.

In the exhibits specified I find a transmitter and a receiver, which, when placed in electrical connection with each other by means of a line wire, and provided with a battery as a source of electricity, are adapted to transmit, and will transmit articulate speech from one station to another.

In the Baxter battery transmitter, I find an instrument which, from its construction, is adapted to produce, and, when properly operated by the voice, will produce electrical undulations in the current traversing the circuit, similar in form to the air waves by which these electrical variations are produced.

In the defendants' receiver, I find an instrument which is adapted to produce vibrations in the air, similar in form to vibrations originally produced in the air at the transmitting station by the voice as I have already explained. The defendants' apparatus, like the Bell apparatus, contains a transmitter, which from its construction is adapted to produce electrical undulations as described, and a receiver which is adapted to retranslate these electricel undulations into vibrations of the air.

The Baxter battery transmitter adopts one of the modes mentioned by Mr. Bell as suitable for the production of electrical undulations similar in form to the air waves produced by the voice, namely, by varying the resistance of the circuit. The precise means adopted in the Baxter transmitter for varying the resistance of the circuit is different from the particular means referred to by Mr. Bell, inasmuch as it utilizes the property of variation in resistance with variation in pressure possessed by various substances.

In my opinion, however, the adoption of one rather than another particular way of varying the resistance of the circuit does not materially affect the substantial likeness of the apparatus of Mr. Bell and defendants, or its method of operation.

Int. 24. Will you state whether the fact to which you refer, that the resistance of substances may be varied by pressure, was one known before the date of Mr. Bell's patent, and recognized in the construction of electrical apparatus; and if you can refer to any elec-

trical works of authority, where this fact is referred to, will you do so, and quote the references to the fact?

Ans. It was known long before the date of Mr. Bell's patent that the resistance of a circuit is varied, without being broken, by variations in the intimacy of contact or amount of pressure between two electrodes in contact, from one to the other of which a current is passing. This fact was noted and recorded by Du Moncel in his book "Applications de l'Electricité," Vol. II., p. 246, edition of 1856, published at Paris in that year. In "Comptes Rendus" for July, 1874, a communication from the same writer described some experiments as to the resistance offered to the current in passing from one electrode to another, in the case where one was a good conductor and the other a poor conductor, and showed that a moderate increase of pressure at the contacts would materially increase the conductivity and thereby the current; and he gave his explanation for this phenomenon.

In Du Moncel, "Applications de l'Electricité," ed. 1856, Vol. I., p. 246, I find the following: —

"Une chose assez curieuse, et qui paraît être au premier abord en contradiction avec la théorie que l'on s'est faite de électricité, c'est que la plus ou moins grande pression exercée entre les pièces de contact des interrupteurs influe considérablement sur l'intensité du courant qui les traverse. Cela tient souvent à ce que les métaux de l'interrupteur ne sont pas toujours dans un état parfait de décapage au point de contact, mais peut-être aussi à une cause physique encore mal appréciée. Ce qui est certain, c'est que, dans les interrupteurs où la pièce mobile de contact est sollicitée par une force extrêmement minime, le courante éprouve souvent des affaiblissement assez notables pour faire manquer la réaction électrique qu'on attend d'eux."

Which I translate as follows: —

"A somewhat curious fact, which at first sight appears to be in contradiction to the views ordinarily received as to the action of electricity, is that the greater or less pressure exercised between the contact pieces of interrupters has an important influence upon the strength of the current which traverses them. This often happens because the metal of the interrupter is not perfectly free from rust at the point of contact, but perhaps also because of a physicial cause as yet but little appreciated. This is certain, that with interrupters in which a movable contact piece is acted upon by a very slight

pressure, the current often suffers such an enfeeblement as to cause a failure in the electrical action which was expected."

The same writer describes in "Comptes Rendus" for July 6, 1874, a series of experiments in which he measured the current in a circuit, part of which consisted of a platinum electrode and a piece of wood, more or less damp, kept in constant contact, but with varying pressure, and says, p. 41, in an article entitled "Récherches sur les transmissions électriques à travers les corps ligneux," as follows: —

"Les expériences que j'avais à faire pour avoir une constatation exacte des effets produits, étaient assez délicates, car une foule de causes étrangères peuvent intervenir, et changer les résultats fournis. Ainsi le dégré de serrage des plaques métalliques de communication avec le bois, son isolement plus ou moins parfait du sol et des murs de l'appartement, où l'on expérimente, la grandeur des surfaces mises en communication avec le circuit métallique, la masse du bois, l'état plus ou moins humide de l'air du cabinet des expériences, le contact fortuit des doigts sur les fils de communication avec le galvanomètre, et l'état d'isolement de ces fils sont autant de causes qui peuvent modifier les résultats que l'on obtient.

. . . . . .

"6. Que le dégré de la pression de la plaque de platine contre le bois a tellement influé sur l'intensité du courant ainsi transmis, qu'étant de 12 dégrés avec un serrage maximum elle est devenue à zéro quand la plaque était abandonnée à son propre poids, et à 5 dégrés seulement avec un faible serrage."

This I translate as follows: —

"The experiments that I have had to make in order to have an exact proof of the effects produced were very delicate, because a number of foreign elements might enter and change the results. Thus *the amount of pressure upon the metallic plates in communication with the wood*, its more or less perfect insulation from the earth or the walls of the room, the size of the surfaces put in communication with the metallic circuit, the mass of the wood, the greater or less humidity of the air, the accidental contact of the fingers with the wires leading to the galvanometer, and the condition of the insulation of these wires, were causes which might modify the results that would be obtained.

. . . . . .

"6. That the amount of the pressure of the platinum plate against the wood has so much influence on the strength of the current thus

transmitted, that from twelve degrees, with a maximum pressure, it became reduced to zero when the plate was pressed only by its own weight, and to five degrees only with a slight pressure."

In Du Moncel's "Traité de Telegraphie Electrique," Paris, 1864, Part IV., p. 559, in speaking of apparatus designed to establish electrical contact, the author says: —

"L'expérience montre que plus la pression des contacts est grande, plus est énergique l'intensité du courant qui les traverse," that is, in English, "Experiment shows that the greater the pressure of the contact pieces, the stronger is the current passing through them."

This fact was also constantly acted upon in the practical use of electrical apparatus; care was always taken that contacts should be firm and with considerable pressure, for otherwise the full and desired strength of current was not obtained.

Int. 25. State more particularly what you have meant by variations in pressure, as applied to the defendants' apparatus, and as applied to the experiments and statements of Du Moncel, which you have quoted.

Ans. By the variations in pressure which I have mentioned, I mean those variations because of which the two contact pieces of hard carbon and platinum are pressed more or less closely together. I do not refer to these variations of pressure as producing change throughout the whole mass of the contact pieces, but simply to those variations which occur at the surfaces in contact. These are simply variations in the force by which the contact pieces are pressed together; and such variations produce variations in the electrical resistance of the joint thus made. The greater the pressure the more intimate is the contact and the less the electrical resistance, and *vice versa*.

Int. 26. What name has been given to that part of a battery telephone which is made to operate by variations in pressure between contact pieces of carbon or other conductor, and what familiar instance of such a telephone can you mention?

In this connection also you may further explain the principle of its operation.

Ans. That variety of the speaking telephone transmitter which is referred to in the question is known as the articulating microphone,

or, more generally, simply as the microphone. The form best known in commerical use is what is called the "Blake transmitter," invented by Mr. Francis Blake, and manufactured for general use by the Bell Telephone Company in the fall of 1878, and now universally employed in the United States.

The microphone consists physically of two electrodes placed normally in contact with a slight pressure, and forming part of a circuit supplied with a current from a battery. A single Leclanché cell is generally employed in practice, though in some of my experiments with certain forms of microphone having large contact surfaces, I used as many as four cells of Leclanché or two of Bunsen.

One of the electrodes of the microphone is so arranged that when spoken to it will take up the vibrational movement of the sound waves. The other electrode is mounted so as not to be similarly affected by them; and the consequence is that the former electrode moves relatively to the latter. This motion of one electrode relatively to the other is excessively minute, but it is sufficient to so affect the current in the circuit that a magneto receiver of the ordinary improved commercial form, conforming to the principles indicated by Fig. 7 of Mr. Bell's first patent, will audibly repeat the words uttered into the transmitter.

To aid in this operation of the transmitter, the electrode which is designed to be more directly vibrated by the voice, is preferably made of such a shape as to offer of itself some considerable surface to the sound waves, or else is mounted upon an extended surface, such as a metallic diaphragm, or a thin board.

There seems to be hardly any limit to the forms which may be given to the microphone. Many materials, including the ordinary metals, can be used for the electrodes; but it has always been the practice to make one of them, at least, of carbon, because this material giver far better results than any other hitherto used. In the Blake transmitter, one electrode is a hemisphere of platinum about $\frac{1}{20}$ of an inch in diameter, slightly flattened, while the other offers a plane surface of hard gas carbon, artificially hardened and polished.

The back electrode, or anvil electrode, as it is sometimes called, is either rigidly held, or is more often so mounted that it can yield

somewhat, but not too readily, to the motions of the electrode directly acted on by the voice. The desired normal contact and pressure in the latter case is commonly obtained by the use of a spring, by gravity, and in other ways.

A speaking telephone on this principle was described in papers filed in the Patent Office by Mr. Berliner, and by Mr. Edison in 1877. In 1878 Prof. Hughes reinvented it, approaching the problem from a somewhat different direction, viz., from vibrations mechanically excited by scratching with a pencil, or by the tramp of a fly, and passing thence to those excited by sonorous waves in the air. He first published a description of his instrument in a paper read before the Royal Society, London, May 9, 1878. Notices of it are to be found in the *Scientific American* supplement, June 8, 1878, and elsewhere.

The action of the microphone in transmitting articulate speech is as follows: The sound waves produced by the voice impress their vibrations directly upon the front or "hammer" electrode, and by virtue of the inertia of the back or "anvil" electrode, as already explained, the vibrations of the first electrode cause corresponding variations in pressure between it and the second electrode. These variations of pressure, by varying the electrical resistance of the microphone contact, create electrical undulations in the current similar in form to the sound waves producing them; and when these electrical undulations pass through the coils of the electromagnet of the receiving telephone they cause corresponding variations in the magnetic state of the core, and thus set the diaphragm into vibrations corresponding to such magnetic changes. By these vibrations of the diaphragm, air waves are finally produced at the receiving station similar in form to those originally produced by the voice of the speaker at the transmitting station.

Int. 27. Did you testify as an expert in the case of the American Bell Telephone Company *et al. v.* Albert L. Spencer *et al.* in the United States Circuit Court within the District of Massachusetts, wherein a decision has been rendered for the complainants; and were you familiar with the telephonic apparatus therein complained of and held by the Court to infringe upon the Bell patents aforesaid; if so, what was the character of the transmitting instrument to which the decision in that case applied?

Ans. I did testify as an expert for the complainants in the Spencer case referred to, and became familiar with the telephonic apparatus complained of therein. The transmitter of that apparatus was an articulating microphone, which operated in the manner and according to the method I have described in my last preceding answer.

[*Adjourned to Dec.* 24, 1883.]

DECEMBER 24, 1883.

Int. 28. Did you testify as an expert in the case of the American Bell Telephone Company *v.* Amos E. Dolbear *et al.*, in the United States Circuit Court within the District of Massachusetts, wherein a decision has also been rendered for the complainants, and were you familiar with the telephonic apparatus therein complained of, and held by the Court to infringe upon the Bell patent No. 174,465? If so, what was the character of the transmitting instrument belonging to the apparatus to which the decision in that case applied?

Ans. I testified in the case referred to, and became familiar with the apparatus in that case. The transmitter was an articulating microphone, and it operated in the manner which I have already described.

Int. 29. You have said that the Baxter transmitter produces electrical undulations by utilizing the property of variation in resistance with variation in pressure possessed by various substances. Please compare the construction and mode of operation of the Baxter transmitter with the construction and mode of operation of the articulating microphone which you have explained, and point out their substantial likenesses and differences. In this connection you may also state what is the practical effect of the changes in the construction of Exhibit Defendants' Transmitter No. 1 and Exhibit Defendants' Transmitter No. 2, as compared with the form of Baxter transmitter shown in the drawings of the patent No. 277,198.

Ans. Both exhibits are articulating microphones whose operation is identical in principle with the operation of the Blake transmitter, the Dolbear transmitter, and the others to which I have referred. The particular manner in which the anvil carbon electrode is mounted is substantially the same as that patented by Mr. Berliner

in 1877. In Exhibit No. 1, the pendulous bar is suspended from an axis which passes through a projection from the bar in the direction of the diaphragm. The effect of this is to increase the normal pressure between the two electrodes, and thus to put the instrument in an adjustment more favorable for good articulation than if the exact arrangement described in the Baxter patent were used. In Exhibit No. 2, this greater normal pressure is secured by the use of a longer adjusting screw attached to the anvil electrode. In all these forms of Baxter transmitter, those shown in the patent and Exhibits Nos. 1 and 2, the hammer electrode is a metallic stud (in the exhibits apparently of platinum), while the anvil electrode consists of a carbon button. The vibrations impressed upon the diaphragm by the voice produce a variation of pressure between the hammer and anvil electrodes on account of the inertia of the latter, as I have described at length in my answer to Int. 26. The action is identical with that taking place in the various forms of articulating microphone to which I have referred.

Int. 30. Please compare Exhibit Defendants' Receiver with the receiving member, L, of the apparatus specifically described in the Bell patent No. 174,465, and shown in Fig. 7 of the drawings thereof, and state what differences in construction you find, and how such differences affect, if at all, the substantial likeness of the two instruments in respect to their function and mode of operation, and the work they do in the transmission of sound.

Ans. The operation of the defendants' receiver is identical with the operation of the receiver shown in Fig. 7 of the Bell patent No. 174,465. In the defendants' magneto receiver there is a permanent horseshoe magnet, about one end of which a coil is wound. One end of the horseshoe magnet therefore forms the core of the electro-magnet. Instead of the membrane and attached armature described by Mr. Bell, an iron diaphragm is used, with its centre opposite that pole of the permanent magnet about which the coil is wound. The diaphragm is connected at its edge with the other end of the horseshoe magnet, so that it is permanently polarized by this contact; being in this respect similar in arrangement to the armature shown in the receiver, I, of the Bell patent No. 174,465, which armature is

polarized through its connection with the electro-magnet. The permanent magnet used in this instrument replaces the electro-magnet shown in the receiver, L, of the Bell patent, which does not affect the substantial likeness of the two instruments, since the function of the battery shown in Fig. 7 is merely to keep the cores of the electro-magnet magnetic. The magnetism of the permanent magnet of the Baxter receiver is substituted for the magnetization produced by the current in the Bell receiver of Fig. 7. The metallic diaphragm of the Baxter receiver replaces the combined armature and membrane diaphragm of the receiver shown in Fig. 7 of the Bell patent No. 174,465. The Baxter receiver contains a peculiar arrangement of the coil, a portion of which is composed of iron wire or ribbon lying between two helices of copper wire. None of these differences, however, in any way affects the substantial likeness between the Baxter receiver and the receiver shown in Fig. 7 of the Bell patent, either in respect to their function or mode of operation, or the work they do in the transmission of sound.

Int. 31. Will you now refer to the second Bell patent, No. 186,-787, and point out the leading features of improvement therein set forth relating to the speaking telephone; and briefly explain so much of the apparatus therein described and shown, as is referred t in the 5th, 6th, 7th and 8th claims?

Ans. The chief improvements which I find in the second Bel patent are the following: —

1st. For the membrane and attached armature, shown in Fig. of the patent No. 174,465, is substituted a plate of iron or steel, o other material capable of inductive action, which can be thrown int vibration by the movement of the surrounding air or by the attrac tion of a magnet. This plate must be of such material, size, thickness and elasticity, and must be so mounted and arranged wit reference to the magnet, that on the one hand the delicate air vibrations characterizing articulate speech may be able to impart their vibration to it without substantial alteration in character, while on the other hand, it is capable of being set into vibration through the action upon it of the minute changes imparted to the magnet by the variations in the current passing through the coil surrounding it, when those variations are of the delicate character which are employed in the transmission of speech in the speaking telephone.

2d. Another important feature described in the Bell patent No. 186,787 is the substitution of a permanent magnet with a coil wound about one end of it, or with a coil wound about a soft iron pole piece in contact with one end of the magnet, for the electro-magnet described in the patent No. 174,465.

3d. The use of a sounding box by which the plate of the instrument is protected from disturbing vibrations.

4th. A speaking or hearing tube for conveying sound to and from the telephone.

Claim 5 is as follows: —

"5. The combination in an electric telephone, such as herein shown and described, of a magnet with a coil upon the end or ends of the magnet nearest the plate."

This claim relates to the special form of magnet suited for use in an electric telephone, the coil being placed about the end or ends of the magnet nearest the plate. The object of thus placing the coil is to render the magnet quicker in its working, that is, more ready to respond with the requisite rapidity to the variations in the strength of the current passing through the coil. A magnet with the coil thus placed responds more quickly by changes in its strength to slight changes in the strength of the current, and hence it is better adapted for use in the speaking telephone than a magnet in which the coil surrounds the whole length of the magnet, and which consequently acts more slowly.

Claim 6 is as follows: —

"6. The combination in an electric telephone, such as herein described, of a sounding box, substantially as herein shown and set forth."

In this claim is mentioned the sounding box, which is combined with the telephone. This sounding box has an important influence in screening the plate of the instrument from the effect of extraneous sounds. The thin air space in front of the plate also exercises an important influence.

Claim 7 is as follows: —

"7. In combination with an electric telephone, as herein described, the employment of a speaking or hearing tube for conveying sounds to or from the telephone, substantially as set forth."

The speaking or hearing tube mentioned in this claim serves to concentrate the sounds produced by the voice upon the diaphragm when used as a transmitter, or to convey to the ear the sounds produced by the diaphragm when used as a receiver.

Claim 8 is as follows: —

"8. In a system of electric telephony, the combination of a permanent magnet with a plate of iron or steel, or other material capable of inductive action, with coils upon the end or ends of said magnet nearest the plate, substantially as set forth."

In this claim I find mentioned the combination of a permanent magnet with coils upon its end or ends, as described, with a plate of iron or other material capable of inductive action. The use of the plate of iron, in connection with the magnet, as described, in a system of electric telephony, furnishes a most excellent method of causing the electrical and magnetic variations of the apparatus to produce corresponding vibrations in the air.

Int. 32. Referring to the defendants' instruments which have been introduced in evidence, will you compare them with the apparatus described in the patent last referred to, and state how far, if at all, you find them to embrace the features or combinations described in the patent and referred to in the claims above specified.

Ans. In the defendants' magneto telephone I find a magnet combined with a plate of iron such as is described in the patent. I also find that this magnet has a coil upon the end nearest the plate, as described in claim 5. This magnet is placed within a sounding box, as described in claim 6. In front of the plate of iron is a cylindrical hearing tube, for conveying to the ear the sounds produced by the vibrations of that plate, as described in claim 7. I find, also, a permanent magnet, as described in claim 8. The mouthpiece of the Exhibit Defendants' Transmitter is so arranged as to leave a thin space filled with air in front of the vibrating plate.

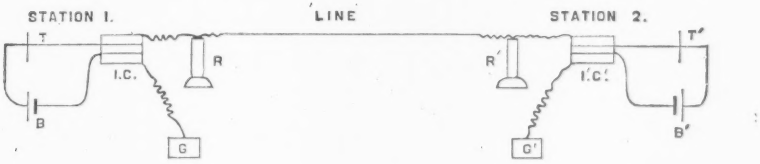
Int. 33. I find in the second Bell patent a statement that the same instrument is used both as transmitter and receiver, and I understand that the electrical and magnetic portions of the apparatus described in Bell's first patent are the same both in the transmitter and receiver, the instruments differing merely in the forms of the cones, one of which is specially adapted to enclose the mouth, while the other is shaped so as to enter or be applied to the ear,

Will you state whether the defendants' magneto telephone is, when properly connected in line with another instrument of the same kind, capable of being used as a transmitter as well as a receiver?

Ans. It is capable of being used both as transmitter and receiver under the circumstances mentioned.

Int. 34. Will you describe the character of the circuits and connections indicated by the structure of the defendants' two instruments, and usual with a speaking telephone apparatus which includes a battery transmitter, and then tell me whether the magneto instruments as arranged at the two ends of the line will be so connected in circuit with each other that without any change speech uttered into one will be heard at the other?

Ans. I make the following drawing to illustrate my meaning: —



In the figure, I C and I′ C′ are two induction coils; B and B′ are voltaic batteries, and T and T′ transmitters in the primary circuits of the coils. R and R′ are magneto telephones placed in a line connected with one terminal of the secondary wire of each induction coil. G and G′ are earth plates, with connecting wires running to the other terminals of the secondary wires of the induction coils. G and G′ are buried in the earth, so that the secondary circuit is completed through the earth, and includes the secondary helices of the two induction coils and the two magneto telephones R and R′. Speech actuating either T or T′ is reproduced in the receivers R and R′. Also, if either R or R′ be spoken into and used as a transmitter, since R and R′ are joined in complete circuit by means of the line wire, the secondary wires of the coils, and the earth, speech will be reproduced in the other receiver as when the apparatus shown in Fig. 7 of the first Bell patent or Figs. 4 and 6 of the second Bell patent is used.

This is the ordinary arrangement, and, as indicated by the construction of the defendants' transmitter, is the arrangement intended

to be used by them. Indeed it is not uncommon on ordinary telephone lines as thus arranged to use one of the magneto instruments as a transmitter, when for any cause the microphone transmitter, the battery or any portion of the primary circuit is out of order.

Int. 35. I understand from your previous testimony, that in a speaking telephone apparatus consisting of transmitters, receivers, batteries and other adjuncts, as shown in the above diagram, the articulate speech uttered into any transmitter is heard at the receiver, as the same articulate speech, in consequence of the electrical undulations similar in form to the sound waves; and that those electrical undulations are caused by the utterances of the speaker which said sound waves are due to or accompany. I wish you would now state, by reference to said diagram, in what part of the whole apparatus, including in that phrase the various circuits, those electrical undulations exist, and in what part they must exist and be operative in order that speech may be transmitted so as to be intelligible to the listener.

Ans. If a person speaks into one of the transmitters, as, for example, T at station 1, the current produced in the primary circuit by the battery B is thrown into the described electrical undulations by the action of the voice upon the transmitter. These undulations occur throughout the whole primary circuit of the induction coil I C.

Similar electrical undulations are produced in the secondary of I C, and in the whole circuit of which it forms a part, including the magneto telephones R R′, and the secondary wire of the induction coil I′ C′. Similar undulations are also produced in the primary of the induction coil I′ C′; but in this circuit they have no importance.

These electrical undulations are produced in the primary circuit by the action of the voice upon the transmitter. It follows, from the relation of the primary and secondary helices of the induction coil, that undulations similar in form are produced in the secondary wire, the line, and the receiving instruments placed in the circuit. It is because of the presence of these electrical undulations in the secondary circuit, and of their similarity to the undulations produced by the voice in the primary circuit, that words spoken into the transmitter are reproduced by the receiver.

Int. 36. In the printed publication Exhibit Overland Telephone Company Pamphlet, there is upon pp. 9, 10 and 11 an anonymous

opinion to the effect that the current derived by induction from an undulating current in the primary circuit of an induction coil is not undulatory but intermittent: have you read the opinion referred to, and if so, how do the statements therein contained in relation to this matter agree or disagree with your opinion founded upon your knowledge and experience of electrical action, or with the established principles of the science of electricity?

Ans. I have read the opinion. The statements therein contained in relation to the nature of the current in the secondary produced by an undulatory current in the primary are entirely at variance with established principles of electrical science. It is a well-known and accepted fact that the existence of currents in the secondary circuit of an induction coil is due to the existence of changes in the current in the primary circuit. The secondary currents are due, not to the fact of flow in the primary, but to the fact of change in the strength of that flow, because unchanging flow in the primary, — that is, a current of uniform strength, — no matter what that strength may be, will not give rise to any current in the secondary. The strength of the current in the secondary depends upon the *rate* of change in the primary current. As Dr. Baxter has correctly stated in his patent No. 277,198, "the induced current sent to line has a strength proportioned to the degree of variation in the battery current."

The time during which currents flow in the secondary is the same as the time during which changes take place in the primary. They will flow in one direction while the primary current is increasing, and in the other while it is decreasing. A current in the primary of the character described by Mr. Bell as undulatory, that is, one in which the changes in strength conform to the sonorous motions of the air, will, like the changes in the density of the air in such a case, exhibit an alternate increase and decrease, gradual in its character, and with an instant of *quasi* rest at each change from increase to decrease or from decrease to increase, just as in the air.

It necessarily follows that the current in the secondary will flow with a strength directly corresponding to the rate of change of the current in the primary, will present gradual instead of abrupt changes, and will have the same dead points when it changes direc-

tion which are exhibited in the change from increase to decrease in the primary, and in the motion of the air particles engaged in producing sound. Its changes will moreover be graphically represented by the same form of curve which represents the changes in the strength of the primary.

CHAS. R. CROSS.

Attest: CHAS. H. SWAN, *Special Examiner.*

STIPULATION.

BOSTON, Dec. 20, 1883.

It is hereby stipulated that the complainants shall close their direct examination of Charles R. Cross on or before Dec. 28; *that the defendants shall begin their cross examination on Thursday, Jan.* 10, 1884, *at* 11 A. M., *at this office, and shall continue the same from day to day thereafter until concluded; that the complainants shall have the right to resume the direct examination with reference to matters developed by the cross examination, and that if defendants shall not appear upon said tenth day of January, cross examination is to be regarded as waived.*

Attest: CHAS. H. SWAN, *Special Examiner.*

BOSTON, Jan. 10, 1884.

At the request of defendants' counsel, and with consent of counsel for complainants, adjourned to January 11.

JANUARY 11, 1884.

Cross Examination by S. S. HOLLINGSWORTH, Esq., *of Counsel for Defendants.*

Cross-Int. 37. When were you first employed by the American Bell Telephone Company?

Ans. As far as I recollect, in June, 1879, in connection with the Dowd suit.

Cross-Int. 38. Have you been in their employ since that time?

Ans. I have from time to time, at their request, undertaken scientific investigations and tests, and have frequently served as their expert in connection with various suits. I have never been connected officially with the company in any way whatever; nor have I ever been a salaried employé of the company.

Cross-Int. 39. What suits have you testified in?

Ans. I have testified in the Dowd suit, the Spencer suit, the Irwin suit, the Dolbear suit, the suit against the People's Telephone Company, the Ghegan suit, the Overland suit, and also in some other suits which I do not specifically recollect.

Cross-Int. 40. In what cases have you made affidavits, as distinguished from depositions?

Ans. I have made affidavits, if I recollect rightly, in the suits in which I have given depositions, with the exception of the Dowd case. I have also made affidavits in some other cases, but do not recollect the infringing parties.

Cross-Int. 41. Have you testified in any interference proceedings in the Patent Office for the plaintiff herein?

Ans. I have.

Cross-Int. 42. In what cases?

Ans. I do not recollect the distinct titles of the cases. My testimony related especially, as far as I recollect, to the use of the speaking telephone and the microphone transmitter, with reference

to the claims of Bell, Berliner, Edison, Blake and others. I have made affidavits in several cases of this kind.

Cross-Int. 43. Are the statements made by you in these various affidavits and depositions correct, and do you entertain now, as an expert, the opinions you have given in these various affidavits and depositions?

Ans. Your question is altogether too broad to be answered categorically. The statements when made were in all cases true, according to the best of my knowledge and belief. In the course of four years of constant study and experiment I have learned a great many facts, of which no one was cognizant when my earlier depositions and affidavits were made. I do not recollect any question of special importance on which I have materially modified my views; but at the same time I could reply much more definitely if I were questioned regarding definite statements, instead of being requested to answer such loose and sweeping inquiries.

Cross-Int. 44. When was your attention first called to Bell's Letters Patent of 1876, No. 174,465?

Ans. I do not recollect the exact date, but Mr. Bell sent me a copy of his patent at a time which, I think, was not very long after it was issued. This I think was the first time that I ever saw a copy of that patent.

Cross-Int. 45. When did you first study that patent for the purpose of ascertaining the invention contained in it?

Ans. I was familiar with all of Mr. Bell's work after January, 1874, and when I first read his patent I understood it to be a statement of the inventions upon which he had been at work for some time. My first study of the patent with reference to any legal proceedings was in connection with the Dowd suit.

Cross-Int. 46. When you first studied that patent with reference to legal proceedings, had you seen and were you familiar with Bell's patent of 1877, No. 186,787?

Ans. I considered both of the Bell patents in connection with the Dowd case. I do not recollect whether I had or had not read the second Bell patent before the date of that suit. I was, however, perfectly familiar with the inventions there described.

Cross-Int. 47. Was the importance of finding a speaking tele-

phone described in the Bell patent of 1876, suggested to you by anybody in your examination of these patents before testifying in the Dowd suit?

Ans. I do not recollect discussing to any great extent the importance of this or of any other matter from a legal or business point of view. I did not consider, at the time that I began the consideration of the question in connection with the Dowd suit, that there was any doubt as to the nature of the inventions described in the patent mentioned, and the description therein of the speaking telephone was taken by me as a fact beyond dispute by any disinterested parties. As far as I can remember, only once, in answer to a casual question of my own, was anything said about the legal bearing of this question. I was, of course, able to see without suggestion or instruction, that from the inventor's point of view, the question was an important one.

Cross-Int. 48. Do you find the transmission of speech spoken of in Bell's patent of 1876?

Ans. I do not find the terms "transmission of speech" used.

Cross-Int. 49. Do you find those terms used in Bell's patent of 1877?

Ans. I do.

Cross-Int. 50. He mentions as one of the objects of his invention in his patent of 1877 the electrical transmission of articulate speech, does he not?

Ans. In the paragraph to which I understand you to refer me, I find the statement that the invention has for its object the simultaneous transmission of two or more musical notes or telegraphic signals along a single wire, with only a single battery, and with very simple instruments; second, the electrical transmission of articulate speech and sound of every kind by the same means; third, the transmission of sounds of every kind without the use of a battery.

Cross-Int. 51. Do you understand Bell's patent of 1877 contains the invention of the electrical transmission of articulate speech?

Ans. I understand that it contains certain improved methods of transmitting articulate speech, but I understand that the invention of Mr. Bell's method of transmitting articulate speech was contained in his patent of 1876.

Cross-Int. 52. Will you point out to me any apparatus described or shown in the drawings of Bell's patent of 1876 by which articulate speech can be transmitted?

Ans. The apparatus shown in Fig. 7 will transmit articulate speech very perfectly.

Cross-Int. 53. Will the apparatus shown in Fig. 5 of the same patent transmit articulate speech?

Ans. I do not suppose it would be possible to practically transmit articulate speech with the apparatus shown in Fig. 5.

Cross-Int. 54. What do you mean by "*practically* transmit articulate speech"? Hitherto you have spoken of the transmission of articulate speech, and now you qualify that by the use of the word "practically": what do you mean by this qualification?

Ans. The apparatus shown in Fig. 5 is not intended to transmit articulate speech; and, with any such tongue as would be used for an armature, in its practical application, the transmission of speech would be impossible. I can conceive, however, of a peculiar tongue of such dimensions that it might possibly vibrate in accord with a sufficient number of the partial tones of the human voice to transmit certain words. I do not think that it would be possible to do more than this (and it is doubtful if it could do even this), and such a transmission I should not consider a practical transmission of speech.

Cross-Int. 55. Would such an apparatus, in your opinion, be found within the claim of the Bell patent of 1876?

[*Objected to as a question of law, and not admissible or competent.*]

Ans. I have never considered the relation of such an imaginary apparatus to the claims in the Bell patent, and do not feel ready to answer a question which is not a scientific one, without at least more time for consideration than I can give at the present moment.

Cross-Int. 56. Why do you say that the apparatus shown in Fig. 5 of Bell's patent of 1876 is not intended to transmit articulate speech?

Ans. An armature arranged as is shown in Fig. 5 is not suited to take up vibrations produced in the air by the voice, and no one would think of employing such a device for the purpose.

Cross-Int. 57. Are the dimensions of that armature given in the patent?

Ans. No specific dimensions are given, but, from the description of the construction and operation of Fig. 5, and of the capabilities of the armature, it is evident what kind of a spring the inventor intended to use.

Cross-Int. 58. Does the apparatus shown in Fig. 5 embody the method and apparatus for the transmission of articulate speech shown in Bell's patent of 1876?

Ans. It does not, as I understand the patent, and with the construction of the apparatus in Fig. 5 which I understand it to imply.

Cross-Int. 59. Would the apparatus shown in Fig. 5, and altered by the substitution for the armature there of the peculiar tongue which you have said you could conceive of, embody the method and apparatus for the transmission of articulate speech claimed in Bell's patent of 1876?

Ans. It would embody Mr. Bell's method, and as an apparatus would, so far as it was effective, be an equivalent for the apparatus of Fig. 7.

Cross-Int. 60. Please describe the peculiar tongue of which you say you can conceive.

Ans. My conception is not definite enough for me to give any precise description. The idea which I had in mind was that it was not absolutely impossible that with a rather broad and thin tongue, even if attached at one end only, some of the characteristic vibrations of speech might be taken up from the air. Such a tongue would vibrate in accordance with a number of sounds.

Cross-Int. 61. Would an apparatus rigged with such a tongue transmit articulate speech?

Ans. You ask me much more than I can tell you with regard to the capabilities of my imaginary instrument. All that I can say is that, if any imaginary reed, acting as I have imagined that it might act, could take up from the air with sufficient exactness the vibrations characterizing articulate speech, and if the reed at the other end of the apparatus was able to reproduce these vibrations with sufficient exactness, the apparatus would transmit articulate speech, otherwise it would not.

Cross-Int. 62. What are the points of difference between the apparatus shown in Fig. 5 and Fig. 7, to which is due the fact that Fig. 7 will transmit articulate speech, and Fig. 5 will not, as you have stated?

Ans. In Fig. 7 the armature is attached by one extremity to the centre of a stretched membrane, while its other extremity is hinged to the leg of the electro-magnet near the edge of the membrane. The membrane is well adapted to take up sound vibrations from the air, and hence, through the attachment of the armature to it, the armature will be set into a vibration corresponding to the air vibrations produced by the voice. At the receiving instrument the membrane acts to impress upon the air the vibrations which are set up in the attached armature.

Cross-Int. 63. The difference, then, is due to the existence of a membrane in Fig. 7 and the attachment of the armature to one end of the magnet near the edge of the membrane, so that the lower end of the armature will be vibrated by the vibrations of the membrane in the case of the transmitter, and will communicate its vibrations to the membrane in the case of the receiver?

Ans. That is the principal difference. Beside that there is the addition of the speaking and hearing cones.

Cross-Int. 64. Are the cones essential to the transmission of articulate speech?

Ans. They are not.

Cross-Int. 65. Are the membranes or diaphragms essential to the transmission of articulate speech?

Ans. They are essential in the specific form of apparatus shown in Fig. 7.

Cross-Int. 66. Is the hinging of the amature essential?

Ans. The amature, instead of being hinged, might, of course, if it was sufficiently flexible, be clamped at one end, or it might be replaced by a little button or plate of iron attached to the middle of the membrane.

Cross-Int. 67. The amature in Fig 5 is clamped at one end, isn't it?

Ans. It is.

Cross-Int. 68. Then the real essential difference between the

two, Fig. 5 and Fig. 7, whereby Fig. 7 can transmit articulate speech, as you have stated, is the presence of the membrane in Fig. 7.

Ans. It is the presence of the membrane and its connection with the amature or its equivalent.

Cross-Int. 69. Would the substitution of a metal plate in front of the magnet, without any armature, be an equivalent for the apparatus shown in Fig. 7?

Ans. It would, if the metal plate were properly mounted.

Cross-Int. 70. What is the limit of thickness of an armature in a telephone embodying the method and apparatus of Bell's patent of 1876?

Ans. I do not know.

Cross-Int. 71. Where a metal diaphragm is substituted and properly mounted for the membrane and armature, what is the limit of thickness of such metal diaphragm?

Ans. I do not know.

Cross-Int. 72. Have you ever experimented in regard to the thickness of such diaphragms?

Ans. I have used diaphragms of different thickness, but not with the specific purpose of ascertaining the limits of thickness that could possibly be used.

Cross-Int. 73. How thick have been the metal diaphragms that you have used?

Ans. I don't recollect that I have used any myself more than one twentieth of an inch thick; but I have not made any special measurements bearing upon the matter.

Cross-Int. 74. Have you known of any metal diaphragms being used that were thicker than this?

Ans. I believe that Mr. Bell has used boiler plate as a diaphragm. I should say that it was over one fourth of an inch thick.

Cross-Int. 75. How small is the force which will transmit speech through such a diaphragm?

Ans. I do not know.

Cross-Int. 76. Was speech transmitted by means of such a diaphragm?

Ans. It was.

Cross-Int. 77. In the tramsmission of articulate speech by the method and apparatus described by Mr. Bell in his patent of 1876, as you have explained it, is there a movement of the armature about the point where it is hinged as a centre?

Ans. As I understand the operation of the apparatus, there is.

Cross-Int. 78. Is such movement essential to the operation of the apparatus?

Ans. When the apparatus is constructed exactly as shown in Fig. 7, I should think that it was, though it is probable that with some modifications it would not be essential.

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Cross-Int. 79. What are the modifications which would dispense with this otherwise essential feature of the apparatus?

Ans. The idea which I had in mind in my last answer was not sufficiently definite to enable me to give you a very clear reply. I had thought of the possibility of using a very flexible armature firmly fastened at one end, and, which, instead of swinging bodily about that end, might be thrown into vibration in segments, so as to produce nodes and loops.

Cross-Int. 80. In the case you have last mentioned, the flexible armature would be thrown out of the plane of rest, would it not?

Ans. Portions of it would be at the loops.

Cross-Int. 81. In either case, therefore, whether you have the armature as shown in Fig. 7, or such a flexible armature as you have spoken of, there would be, with reference to the magnet, a to-and-fro motion of the whole or some parts of the armature, would there not?

Ans. Yes.

Cross-Int. 82. Is what you have said with respect to the motion of the armature, true of the armature in the receiving as well as the transmitting part of the apparatus?

Ans. So far as concerns the nature of the motion, it is.

Cross-Int. 83. What differences are there, apart from the nature of the motion?

Ans. The cause of the motion is different, the result of the mo-

tion is different, the forces resisting the motion are different, and the amount of the motion is different.

Cross-Int. 84. What is the cause of the motion in each case?

Ans. In the case of the transmitter the armature is set into vibration by the membrane, which membrane is set into vibration by the sound waves. As the transmitting apparatus is constructed, the motions of the armature are determined by the vibrations of the membrane. The armature is perfectly under the control of the membrane, and therefore vibrates in accordance with the vibrations of the membrane, so that any change whatever in the nature of these produces a corresponding and similar change in the motions of the armature. On the other hand, the armature of the receiving instrument is set into vibration by the variations in the strength of the magnet of the receiver produced by the electrical undulations traversing the line wire.

Cross-Int. 85. What is the relative extent of the motions of the armature of the transmitter and of the receiver, and what causes any difference in the extent of this motion?

Ans. I have never measured the relative motion of the armatures of the transmitter and of the receiver, but know that the motion of the latter is very much less than that of the former. This is due to the fact that the armature of the transmitter is set into vibration by the powerful impulses of the voice acting upon the membrane with which it is connected, while the armature of the receiver is set into vibration by the comparatively feeble changes in the strength of the magnet of the receiver due to the electrical undulations produced in the line wire by the action of the transmitter.

Cross-Int. 86. Where a metal plate is substituted for the diaphragm and armature in Fig. 7, has it a motion towards and from the poles of the magnet in the transmission of articulate speech, similar to what you have spoken of in the case of an armature?

Ans. The central portion of the metallic plate which is opposite the pole of the magnet has a motion similar in form to that of the end of the vibrating armature in Fig. 7. I am assuming that the metallic diaphragm is fixed at its edges with its centre opposite the pole of the magnet, as in the ordinary receiving telephone now in common use.

Cross-Int. 87. Is there any limit to the diameter of the membrane or of the metallic plate used as a membrane in the receiver of a telephone constructed according to Bell's patent of 1876?

Ans. I understand the question to mean whether there is any limit beyond which the transmitter or receiver would be absolutely inoperative. Considering simply size of membrane without reference to the magnitude of the attached armature, there is no limit in theory; and I think that any size of membrane that could be procured, unless it were excessively small, would be capable of serving to a certain extent for the transmission and reproduction of speech. Practically, however, in accordance with facts well known for a great many years to those familiar with acoustic apparatus, one would not choose for such an apparatus either a very large or a very small membrane.

Cross-Int. 88. Is your last answer equally true where a metallic plate is substituted for the diaphragm and armature shown in Fig. 7 of Bell's patent of 1876?

Ans. I cannot express myself in so broad a manner with regard to metallic plates: 1st, because such plates can be made practically unlimited in their size; and, 2d, because the vibration of large metallic plates is more difficult to secure than that of large membranes. I know, however, that metallic plates of very considerable size can be used in a receiver.

Cross-Int. 89. Can you tell me any more definitely than you have in your last answer how large sized a metallic plate can be used in a transmitter?

Ans. Not from my own experience. Very likely it might be possible to transmit speech with a plate several feet square, although such a plate would be exceedingly unsuitable for the purpose.

Cross-Int. 90. Are the air vibrations set up by articulate speech of sufficient strength to cause a to-and-fro motion in a piece of boiler iron?

Ans. They must, of course, however feeble, be sufficient to produce a minute though perhaps physically imperceptible motion in such a plate. I have never investigated the precise nature of the motion which takes place when speech is transmitted using as thick a plate as this.

Cross-Int. 91. Is a permanent magnet equivalent to the electro-magnet and battery shown in Fig. 7 of Bell's patent of 1876?

Ans. It is for the purpose of transmission of speech.

Cross-Int. 92. Does the quality of inarticulate sound differ from the quality of articulate speech?

Ans. It does.

Cross-Int. 93. Has this difference any peculiarity not possessed by the difference between the quality of two different inarticulate sounds?

Ans. The difference in quality between articulate and inarticulate sounds is of the same nature as the differences in quality existing between different articulate sounds or between different inarticulate sounds, but is much greater in degree.

Cross-Int. 94. What is the difference in quality indifferent inarticulate sounds due to?

Ans. To differences in the number, intensity and pitch of the various overtones which are combined with the fundamental sound.

Cross-Int. 95. This difference is greater between articulate speech and inarticulate sound than between any known inarticulate sounds, is it?

Ans. Considering simply the quality of any single articulate sound, it is not.

Cross-Int. 96. Why do you say, then, that the degree of difference between articulate speech and inarticulate sound is greater than the degree of difference between the quality of two different inarticulate sounds?

Ans. Because, as a brief, comprehensive and general statement, this is true. Nevertheless, imitations of vowel sounds may be produced by combinations of tuning forks or reeds, and remarkable imitations of the human voice have been produced with some of the speaking machines. I think that every one recognizes a great distinction between the articulate sounds of the human voice and all other sounds which we know. And even in cases where the articulation is indistinct or absent, one would readily distinguish the voice of a singer from the *vox humana* stop of an organ.

Cross-Int. 97. What constitutes the difference between articulate speech and inarticulate sound?

Ans. The various combinations of fundamental and overtones, which I have already explained. There are, of course, also the variations in the way in which the sounds begin and end, just as with various musical instruments.

Cross-Int. 98. Who first represented sound waves by the kind of diagram shown by you in your answer to Int. 10?

Ans. I do not know who was, historically, the first person to do this. It has been in common use for twenty-five or thirty years at least, and probably dates much further back.

Cross-Int. 99. Have you repeated the experiments performed by Prof. Blake, and referred to by you, for reproducing graphically sound waves?

Ans. I have not.

Cross-Int. 100. Do those diagrams exhibit any form of sound wave peculiar to articulate speech?

Ans. The curves in question probably give only a very imperfect representation of the undulations characterizing articulate speech, by which they were produced. I notice, however, in some of these, elements which I have found present in the study of articulate speech by other optical and graphical methods.

Cross-Int. 101. Is there any form of wave shown there which is peculiar to articulate speech?

Ans. I do not think that anything except articulate speech could exactly produce the series of undulations shown in the first set of Prof. Blake's drawings, and I think that the most perfect imitation of the vowel sounds by means of forks or reeds would give different curves from those shown in the second set.

Cross-Int. 102. Do I understand, then, that there is a difference in the character of the curves representing graphically the sound waves caused by articulate speech from those representing the sound waves caused by inarticulate sounds, — such that it can be seen by examination of the drawings?

Ans. If we could have a perfect drawing which should represent all of the variations, a person who had made himself familiar with the forms of curve produced by different sounds would undoubtedly be able to determine those produced by articulate speech from those produced in other ways. In the case of actual curves which have

been drawn or constructed to record the form of vibrations, when only a single vowel sound is uttered, the curve could probably be imitated to a certain extent by curves representing or produced by combinations of inarticulate sounds. When a sentence or even a complete word is spoken, I think that the resulting curves would readily be distinguishable if one were familiar with the various curves which could be produced by different sounds. The difficulty of distinguishing with absolute certainty in the case of the vowels arises, 1st, from the imperfection of our methods of recording such vibrations; and 2d, from the fact that not having been recorded, no one can know exactly how the record of some of the minuter variations would appear to the eye.

Cross-Int. 103. In what consists the difference in the graphic form of the curves representing articulate speech from those representing inarticulate sounds, which enables one familiar with the forms of the sound waves of both kinds when graphically represented to distinguish between them?

Ans. In the case of the vowel sounds, minute study might be necessary to distinguish these from imitations. In the case of words and sentences, the mode of variation in the amplitude of the curve, in connection with the varying form of the curve, the change of the curve in passing from one word or syllable to the next, would be the chief factors enabling one to reach a true conclusion in the matter?

Cross-Int. 104. There are then certain distinctive features in the graphic representation of sound waves caused by speech which enable one who is sufficiently skilled in reading such graphic representations to know that they represent the sound waves of articulate speech, and not of inarticulate sound?

Ans. If the graphical representation is a perfect one, there is no doubt that this would be the case.

Cross-Int. 105. In the first of Prof. Blake's drawings referred to in your examination, do the curves there shown exhibit the peculiarity which would enable a skilled person to say that they represent sound waves set in motion by speech?

Ans. Taking the whole set of curves, they could not have been produced in any other way; and I think that one sufficiently skilled

in the study and interpretation of such graphical records would know at least that they were produced by the human voice.

Cross-Int. 106. Will you point out what it is in these curves that enables you to say that they were produced by the human voice?

Ans. In the original photographic plates of Prof. Blake from which this drawing is copied, a whole sentence is on a single long plate, the curve being continuous from one end of the sentence to the other. The straight lines joining the various series of curves show that there were intermissions between the different sounds by which these were drawn. The different curves representing the various syllables of a single sentence differ from each other very considerably, showing a different relation between the fundamental and overtones, although the pitch of the fundamental is not very far from being the same throughout the whole sentence. This last fact is shown by the approximate equality of the horizontal distances from one sinuosity of a wave to the next. Now, if separate sounds from any musical instrument had produced these curves, unless the pitch of successive sounds differed far more than is apparent in the drawing, the successive groups of curves would have substantially the same form; that is, there would be the same relation between the fundamental and overtones present, which is not the case. Also, though I have never made a study of these curves with the design of determining the mode by which a curve of unknown origin was produced, I can yet notice some similarities to vibrations of certain vowels which I have observed optically or graphically. Finally the varying amplitude or transverse dimensions of the curves corresponds with those which have been obtained in the case of curves drawn in other ways, and corresponds also to what I know of the logographic or air pressure produced when different sounds are uttered.

In what I have said thus far, I have referred especially to the sentence "Brown University." In the second sentence, — "How do you do," — the elements are harder to distinguish, for two reasons: 1st, the vowel sounds of the three last words are the same, while the method does not readily record the different consonant sounds; and, 2d, either because a higher pitch of voice was used, or, more

likely, because the sensitized plate was moved less rapidly, the curves are so compressed that some of their finer variations are probably obliterated. Nevertheless, even with this imperfect curve, I think that one well skilled in the study and interpretation of such drawings would say at once that it must have been produced by the human voice. I have assumed, what was actually the case, that in drawing the curves the sensitized plate was moved uniformly, or very nearly so.

Cross-Int. 107. Could a person skilled in reading graphical representations of sound waves say whether the curves in the first drawing of Prof. Blake represented the sound waves caused by articulate speech?

Ans. I think that he would know that the waves were produced by articulate speech, though he might not be able to determine what some of the precise sounds were, largely because of the difficulty of recording the consonants.

Cross-Int. 108. In answer to Int. 8, you say that it is because of this similarity that speech is transmitted: what similarity do you refer to?

Ans. The similarity between the vibrations of the air accompanying sounds uttered into the transmitter and the electrical undulations which are produced by them.

Cross-Int. 109. Will the pitch, loudness and quality of inarticulate sounds be reproduced by electrical undulations?

Ans. They will be so reproduced.

Cross-Int. 110. Can they be reproduced by an apparatus which will not reproduce articulate sounds?

Ans. An apparatus which was too imperfect to reproduce the finer variations characterizing articulate speech might yet be perfect enough to give a tolerable reproduction of many inarticulate sounds.

Cross-Int. 111. Would such an apparatus embody the method and apparatus contained in Bell's patent of 1876?

Ans. If it transmitted such sounds by means of electrical undulations similar in form to the sound waves producing them, it would. No apparatus not employing this method could perfectly transmit even inarticulate sounds.

Cross-Int. 112. If a telephone is spoken into, and you are able

to distinguish at the receiver the form and inflection of the words, and the *timbre* of the speaker's voice without being able to distinguish the words themselves, would such an apparatus embody the method and apparatus of Bell's patent of 1876?

Ans. Any apparatus which is capable of actually transmitting and reproducing quality of any and all sounds must operate according to Mr. Bell's method.

Cross-Int. 113. If a telephone is spoken into and you can distinguish at the receiving instrument a single word, would such telephone embody the method and apparatus of Bell's patent of 1876?

Ans. I do not know of any telephone with which this can be done which does not, when actually transmitting a word, employ Mr. Bell's method.

Cross-Int. 114. Then a telephone which transmits a single word does necessarily employ the method and apparatus of Mr. Bell's patent of 1876, does it?

Ans. If I heard at the receiving end of any telephone line a single word actually transmitted with its quality clear, I should feel justified from what I know in concluding that it employed Mr. Bell's method.

Cross-Int. 115. Suppose you heard at a receiver words which sounded like "Hallo, hallo, do you hear that? Do you hear me now?" and yet could not distinguish accurately the words, although you could clearly distinguish the inflections and general characteristics of the speaker's voice; would you say the instrument employed embodied the method and apparatus of Bell's patent of 1876?

Ans. I should think that if the general characteristics of the speaker's voice were reproduced, Mr. Bell's method was used in reproducing those characteristics. Of course variations in pitch might be transmitted without employing Mr. Bell's method. It is also possible that the speaker might be recognized by the listener at the receiving telephone, from his manner of intonation, even with a circuit-breaking transmitter.

Cross-Int. 116. Can the sentences referred to in the last question be understandingly transmitted by a circuit-breaking transmitter?

Ans. Not by a transmitter which operates simply by breaking the circuit.

Cross-Int. 117. Can the Reis transmitter be made to transmit such sentences?

Ans. The Reis transmitter cannot be made to transmit articulate speech when it is operated simply as a circuit-breaker in the manner described by Reis; but, as is well known, if it is so operated as not to break the circuit, or as not to break the circuit too frequently, but to act as a microphone, it can transmit speech so that it can be recognized by a person provided with a suitable receiver.

Cross-Int. 118. Int. 17 asks whether the substitution of one of the ways mentioned for varying the strength of the current for the other, changes substantially the character of the apparatus as an apparatus for transmitting sound. To which you answered that it did not: why doesn't it?

Ans. Because the aim of the apparatus is to transmit sounds by employing electrical undulations similar in form to the sound waves which produce them: and, provided such undulations are produced and utilized, I do not see that, so far as the method is concerned, or so far as the character of the apparatus is concerned, it is material whether these undulations are produced by varying the electromotive force or by varying the resistance.

Cross-Int. 119. How do you know that the electrical variations produced through the transmitter are similar in form to the sound waves actuating the transmitter?

Ans. 1st, Because this is a necessary consequence arising from the way in which they are produced, as will be apparent to any one familiar with the laws of electrical induction. 2d, From the fact that when acting upon a receiving telephone they cause it to reproduce a sound similar to that actuating the transmitter.

Cross-Int. 120. Has it ever been demonstrated that these electrical variations are similar in form to the sound waves actuating the transmitter which produces them?

Ans. I have just given two demonstrations so perfect and so complete, that no scientific man and no one competent to judge of the matter has considered further demonstration necessary.

Cross-Int. 121. Have these demonstrations that have been so conclusive to the mind of the scientific world been published?

Ans. The laws of induction have been known for a great while,

and, as soon as Mr. Bell stated his method and exhibited his apparatus, the foremost physicists of both England and America saw in the apparatus the embodiment and proof of a method at once simple and wonderful, and saw in the method the necessary and apparently the only way in which speech could be transmitted. Their views of the matter were made public at the time. The similarity in form between the electrical waves and the sound waves has been universally accepted by scientific men, and very frequently stated; and I have never seen in any scientific publication anything to indicate that a contrary view has been held by scientific men.

Cross-Int. 122. [*Question repeated.*]

Ans. I do not see that I can reply to this any more clearly than I have already done in my last answer.

Cross-Int. 123. Then you don't know whether the two demonstrations which you have just given, and which you say are so complete and so conclusive that no scientific man and no one competent to judge in the matter has considered further demonstration necessary, have been published.

Ans. I have made no statement from which this inference can possibly be drawn.

Cross-Int. 124. Well, have they been published or not?

Ans. I have stated in my answer to Cross-Int. 121 that, as soon as Mr. Bell stated his method and exhibited his apparatus, the foremost physicists in both England and America saw in the apparatus —and I should have added in the results obtained with it— a proof of the use of the method in question; that is, a proof of the production and utilization of such electrical undulations. I have also said that their views of the matter were made public at the time. I have further said that the existence of such similarity in form has been very frequently stated, by which I intended to be understood that it had been stated in print.

Cross-Int. 125. You have been asked whether it has ever been demonstrated that the electrical undulations are similar in form to the sound waves actuating the transmitter which produces them, to which you answered as follows: "I have just given two demonstrations so perfect and so complete that no scientific man and no one competent to judge of the matter has considered further demon-

stration necessary." You have been asked three times now whether these demonstrations made by you have been published, and thus far you have failed to state whether or not they have been published. I now ask you for the fourth time whether either or both of these demonstrations so made by you have been published.

Ans. I exceedingly regret that the wording of the question which I have been asked three times, has been so obscure to me that I have failed to understand its exact import, and I am not certain that even now I understand exactly what is called for beyond what I have already said. If the question asked me means whether I individually have published the two demonstrations given in my answer to Cross-Int. 119, and referred to in my answer to Cross-Int. 120, I reply that I have not done so, because it would merely be publishing facts which have been known to and recognized by scientific men ever since the first exhibition of Mr. Bell's telephone. If the question asks whether in print these facts have been given, and understood to be proofs of the similarity in form which we are considering, it seems to me that I have already answered it.

Cross-Int. 126. Is the coil on one end of the electro-magnet shown in Fig. 7 of Bell's patent of 1876 adjustable, or is it intended to be at the end of the leg?

Ans. In the figure it is shown as covering the whole leg except the extreme end. Nothing is said in the patent about its adjustability; nor do I see any apparatus for adjusting the coil shown in the figure.

Cross-Int. 127. There is nothing in the patent, then, fixing the location of that coil at any particular spot upon the core, is there?

Ans. I see nothing beyond the indications of the figure.

Cross-Int. 128. Do you, in any of the figures or in the specification of that patent, find the location of the coil fixed at any spot upon the core?

Ans. I do not, beyond the fact that the coil covers only one leg of the magnet.

Cross-Int. 129. Were not all the modes of varying the resistance of a circuit mentioned by Bell in his patent of 1876 known before that time?

Ans. They were.

Cross-Int. 130. Does the patent show any apparatus by which the voice can vary the resistance of the circuit in any of the ways of varying such resistance suggested by Bell in his patent?

Ans. The patent does not show any specific way of doing this; but, with the suggestions given in the patent, I think that any one familiar with electrical and acoustic apparatus at the date of the patent would have seen immediately how he must go to work to construct an apparatus which should use this particular way of employing Mr. Bell's method.

Cross-Int. 131. Did Bell ever construct such an apparatus?

Ans. He did.

Cross-Int 132. When?

Ans. I do not recollect the date when he first employed this means of varying the electrical resistance in the telephone, but I think that it was not later than the spring of 1876.

Cross-Int. 133. What particular mode did he employ when he first did this?

Ans. The first mode that I know was the employment of a wire attached to a diaphragm and dipping into mercury or some other conducting liquid.

Cross-Int. 134. What was the first method of varying the resistance in the circuit in a telephone that came into practical use, and when did it come into practical use?

Ans. The first way of varying the resistance which was practically used in a telephone circuit was by varying the pressure between contact pieces of carbon, or some other conductor, in the various forms of microphone. Instruments operating on this principle were described in the patents of Mr. Berliner and Mr. Edison issued early in 1878. The Edison telephone was in use as early as the summer of 1878. The Blake microphone transmitter was first put into general use in the fall of 1878.

Direct Examination resumed.

Int. 135. In your answer to Cross-Int. 48 you say that you do not find the terms "transmission of speech" used in Mr. Bell's patent of 1876: will you state what you do find set forth in that patent which enables you to understand that as matter of fact the

apparatus delineated in Fig. 7 and described in the specification of that patent, is intended for and capable of the transmission of speech?

Ans. I find in the specification a description of the construction and operation of the apparatus shown in Fig. 7. The inventor states that when a sound is uttered into the cone of the transmitter its membrane is set into vibration, causing the armature to partake of its motion, and so to produce electrical undulations which are similar in form to the air vibrations caused by the sound. The action of this undulatory current upon the armature of the electromagnet of the receiver causes this armature to copy the motion of the armature of the transmitter. Having described the construction and electrical operation of this instrument, Mr. Bell then proceeds to state as a consequence of this method of operation of the apparatus the electrical transmission of speech, saying that "a similar sound to that uttered into A is then heard to proceed from L." I know from actual and frequently repeated experiments that an apparatus constructed in accordance with the directions and figure of the patent is as a matter of fact capable of transmitting articulate speech so perfectly that a person at the receiver can readily understand the articulate sounds uttered into the transmitter. That feature of Mr. Bell's method to which most prominence is given in the specification is similarity of form between the air waves and the electrical undulations. The patent says, regarding the electrical undulations, "These undulations are similar in form to the air vibrations caused by the sound." This is also the only feature specifically mentioned in the fifth claim of the patent, which claim reads as follows: —

"5. The method of and apparatus for transmitting vocal or other sounds telegraphically, as herein described, by causing electrical undulations similar in form to the vibrations of the air accompanying the said vocal or other sounds, substantially as set forth."

This feature of similarity in form between the electrical undulations and the air vibrations producing them secures transmission of quality. It has no purpose, function or effect except the transmission of quality, which includes articulate speech. This correspondence of form is the essential electrical novelty which distinguishes this apparatus from all others known to the community before it.

Int. 136. In your answer to Cross-Int. 51 you speak of Bell's patent of 1877 as containing certain improved methods of transmitting articulate speech, and then you go on to say that you understand that the invention of Mr. Bell's method of transmitting articulate speech was contained in his patent of 1876: in what sense did you use the term "methods" when referring to Bell's second patent, and in what sense did you use the term "method" as applied to the invention set forth in Mr. Bell's first patent?

Ans. I used the term "method" in connection with the second patent, meaning by it the separate modes or ways of producing electrical undulations similar in form to the sound waves.

What I have especially referred to as Mr. Bell's method, and which is described in his first patent, is his method of transmitting speech by means of electrical undulations similar in form to the air waves producing them, and not to specific ways of accomplishing this result.

CHAS. R. CROSS.

Attest: CHAS. H. SWAN, *Special Examiner.*